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FINAL TASK-SPECIFIC PLAN FOR RADIOLOGICAL CHARACTERIZATION, REMEDIATION, AND FINAL STATUS SURVEYS AT SITE 6

09/01/2014

TETRA TECH EC, INC.

Base Realignment and Closure
Program Management Office West
1455 Frazee Road, Suite 900
San Diego, California 92108-4310

CONTRACT NO. N62473-10-D-0809
CTO NO. 0025

FINAL

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September 2014

DCN: RMAC-0809-0025-0006

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ABBREVIATIONS AND ACRONYMS

APP	Accident Prevention Plan
AST	aboveground storage tank
cm^2	square centimeter
cm/s	centimeters per second
cpm	counts per minute
DAC	derived air concentration
DCGL	derived concentration guideline level
$DCGL_W$	wide-area derived concentration guideline level
DFW	definable feature of work
dpm	disintegrations per minute
DQO	data quality objective
FSS	Final Status Survey
GPS	global positioning system
HEPA	high efficiency particulate air
IR	Installation Restoration
LBGR	lower boundary of the gray region
LLRW	low-level radioactive waste
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
$MDCR_{SURVEYOR}$	MDCR calculated assuming a surveyor efficiency
NaI	sodium iodide
NAVSTA TI	Naval Station Treasure Island
pCi/g	picocuries per gram
Ra-226	radium-226
RASO	Radiological Affairs Support Office
RASS	Remedial Action Support Survey
RWP	Radiation Work Permit
SOP	Standard Operating Procedure
SSHP	Site Safety and Health Plan

ABBREVIATIONS AND ACRONYMS
(Continued)

SU	survey unit
TSP	Task-specific Plan
TtEC	Tetra Tech EC, Inc.
UST	underground storage tank

TASK-SPECIFIC PLAN FOR RADIOLOGICAL CHARACTERIZATION, REMEDIATION, AND FINAL STATUS SURVEYS AT INSTALLATION RESTORATION SITE 6

1.0 INTRODUCTION

This Task-specific Plan (TSP) provides the details for the Characterization Survey, Remedial Action Support Survey (RASS), and Final Status Survey (FSS) of Installation Restoration (IR) Site 6 at Naval Station Treasure Island (NAVSTA TI), San Francisco, California. The survey will be conducted in accordance with the general approach and methodologies in the Radiological Management Plan and Standard Operating Procedures (SOPs) provided in Attachment 4 to the Characterization and Remedial Support Survey Work Plan (Work Plan) (TtEC 2014a). The surveys will conform to the requirements of the Accident Prevention Plan (APP)/Site Safety and Health Plan (SSHP) (TtEC 2014b) and the Radiation Protection Plan, Attachment 3 to the Work Plan, prepared for the survey program.

1.1 Site Description and Historical Summary

IR Site 6 is the former fire training school, used for various firefighting training activities from 1944 to 1992. IR Site 6 was initially bounded by Avenues I and M and 14th Street, and encompassed approximately 3.4 acres. Elevated concentrations of dioxin detected in soils in 2003 resulted in the expansion of the site to include an adjacent former parking and storage area for a total area of 4.3 acres of open space in the northeast portion of NAVSTA TI. Most of the site is paved except for the southern boundary, which is unpaved, flat, and covered with vegetation. The location of IR Site 6 within NAVSTA TI is shown on Figure A-1 in Appendix A.

In 2007, the fenced-in area between Avenues I and M and 14th Street was designated a staging area for low-level radioactive waste (LLRW) consisting of radiologically impacted soil from a removal action being performed at adjacent IR Site 12. In 2007 and 2008, soil from the IR Site 12 removal action was stockpiled directly on the ground surface and possibly on the concrete foundation of the former fire training school building. Since the single stockpiling event, soil has been staged in specially designed roll-off bins until the material is shipped for off-site disposal. Based on existing data, only one radionuclide of concern was identified for IR Site 6, radium-226 (Ra-226). LLRW was not stored within the former parking and storage area.

Between December 2012 and February 2013, Engineering/Remediation Resources Group, Inc. performed a corrective action consisting of excavation of petroleum-contaminated soil in the Underground Storage Tank (UST)/Aboveground Storage Tank (AST) 240 Area located within IR Site 6 for disposal followed by backfill of clean import soil and asphalt pavement. A total surface area of 3,396 square feet was excavated with the top 4 feet of soil being radiologically screened on screening pads in 6-inch lifts. The walls of the excavated trench and excavation bottom of the 4-foot trench were also radiologically screened. The survey and soil data indicated that the radiological activity of all of the samples was indistinguishable from background as compared to the reference area soil sample results provided (TtEC 2013). All of the excavated soil was classified as non-LLRW and transported to the Potrero Hills Landfill in Solano County, California, for disposal (TtEC 2013). Based on the radiological survey activities, the original Radiologically Controlled Area fence line along the northwestern boundary was moved approximately 18 feet further south, after completion of the UST/AST 240 excavation activities where portions of the northern boundary were radiologically released. No debris was encountered in the excavations.

The Final Historical Radiological Assessment – Supplemental Technical Memorandum (TriEco-Tt 2014) indicates that the Former Parking and Storage Area is potentially radiologically impacted as the open area south of Former Building 327 (Salvage Building) was used as a salvage yard. The exact location of the salvage yard is not defined. Former Building 327 is located within the Former Parking and Storage Area south of Building 461. The approximate location of Former Building 327 within the Former Parking and Storage Area is shown on Figure A-1.

1.2 Previous Characterization Survey

In April 2009, a gamma walkover survey was conducted within the original fenced boundary of IR Site 6 (i.e., the area bounded by Avenues I and M and 14th Street). The results of the survey indicated gamma radiation levels above the mean background plus 3-sigma (σ) investigation level at three locations towards the center of the site (Appendix B). This fenced area is currently posted as a Radioactive Materials Area and access is controlled. A scoping survey of roadways and housing areas was performed between September 2013 and April 2014 (Gilbane 2014). Results of the gamma scans of Avenue M and the roadway into the Former Parking and Storage Area located within IR Site 6 indicate that differing populations are within the data set and that further investigation of these areas should be performed (Appendix C).

Based on past site history and the results from the 2009, 2012, and 2013 surveys, the ground surfaces (soil, asphalt, and concrete) of IR Site 6 will be surveyed. Prior to the survey activities in the Former Parking and Storage Area, the asphalt, concrete, and vegetative surfaces, including the former roadway into the parking area, will be removed so that the original ground surface of the entire site can be surveyed. The existing concrete, soil, and asphalt surfaces located within the fenced-in area of IR Site 6, which was previously used to stockpile radiologically impacted soil, will be surveyed as is. If contamination is identified, remedial action will be undertaken to address the contamination, and RASSs will then be conducted. The survey, remediation, and RASSs will be conducted in accordance with the Radiological Management Plan, SOPs, and this TSP to verify the removal of fixed contamination in the affected area.

In accordance with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (DoD et al. 2000), all of IR Site 6 will be divided into a series of MARSSIM Class 1 survey units not to exceed 2,000 square meters in size. The locations of the survey units are shown on Figure A-2. If locations of contamination are identified during performance of the Class 1 survey, these areas will be remediated, and subsequent RASSs will be performed until the release criterion for Ra-226 is achieved. The surveys, remedial actions, and subsequent RASSs will be designed to achieve results that can be used as an FSS to provide a complete FSS report for IR Site 6. This report will demonstrate that no fixed or removable contamination remains at levels exceeding the release criteria and soil concentrations are comparable to background.

2.0 PREPARATION AND CHARACTERIZATION SURVEYS

Any miscellaneous trash and debris present within IR Site 6 will be removed and surveyed as materials and equipment in accordance with SOP-003, Release of Materials and Equipment from Radiologically Controlled Areas, before the survey activities are begun. Materials identified as having contamination present above the levels specified in Table 2-1 will be packaged for subsequent decontamination or storage and disposal.

2.1 Original IR Site 6

2.1.1 Survey of Soil Surfaces

The soil surfaces will be surveyed using Tetra Tech EC, Inc.'s Radiological Affairs Support Office (RASO)-approved vehicle towed array system and/or a Ludlum Model 2350-1 survey meter equipped with a Ludlum Model 44-10 2-inch by 2-inch sodium iodide (NaI) detector (or equivalent). One hundred percent scan surveys for gamma radiation will be conducted on the accessible surfaces. Systematic sampling will be performed as specified in this TSP. Based on the scan data, biased samples will also be collected at areas exceeding the survey unit mean plus 3-σ, where σ is the standard deviation of the gamma readings in the survey unit. At each systematic (and biased) sample location, a static measurement will be collected. At each systematic and biased location, soil samples will be collected from the soil surfaces.

Static measurements will be collected using a Ludlum Model 2350-1 survey meter equipped with a Ludlum Model 44-10 2-inch by 2-inch NaI detector (or equivalent). Locations identified as having contamination present above the levels specified in Table 2-1 will be further characterized and subsequently remediated until the post-remediation confirmation readings do not indicate activity greater than the release criteria, as detailed in Section 3.0, and soil concentrations are comparable to background.

2.1.2 Concrete and Asphalt Surfaces

The concrete and asphalt surfaces will be surveyed using a Ludlum Model 2360 survey meter equipped with a Ludlum Model 43-37 gas flow proportional detector (or equivalent) and/or a

Ludlum 43-68 gas flow detector (or equivalent). One hundred percent scan surveys for alpha and beta radiation will be conducted on the accessible surfaces. Systematic sampling will be performed as specified in this TSP. At each systematic (and biased) sample location, a static measurement and a swipe sample will be collected. Static measurements will be collected using a Ludlum Model 2360 survey meter equipped with a Ludlum Model 43-68 gas flow proportional detector (or equivalent). Locations identified as having contamination present above the levels specified in Table 2-1 will be further characterized and subsequently remediated until the post-remediation confirmation readings do not indicate activity greater than the release criteria, as detailed in Section 3.0.

2.2 Former Parking and Storage Area

2.2.1 Asphalt and Concrete Surfaces

The asphalt and concrete surfaces covering the Former Parking and Storage Area will be surveyed in 50-foot by 50-foot grids using Tetra Tech EC, Inc.'s (TtEC's) RASO-approved vehicle towed array system and/or a Ludlum Model 2350-1 survey meter with a Ludlum Model 44-10 2-inch by 2-inch NaI detector (or equivalent). Note that all 50-foot by 50-foot grids will be segregated pending soil sample results from beneath the corresponding asphalt. However, any asphalt or concrete exhibiting gamma readings exceeding the investigation level in a discrete area (i.e., less than 100 square feet) indicating a highly contaminated area or object (i.e., gamma readings exceeding mean of the survey unit plus 3 σ) will be disposed of as LLRW.

Following asphalt and concrete removal, the underlying soil will be surveyed as a Class 1 area. The soil surface will be surveyed using TtEC's RASO-approved vehicle towed array system and/or a Ludlum Model 2350-1 survey meter equipped with a Ludlum Model 44-10 2-inch by 2-inch NaI detector (or equivalent). One hundred percent scan surveys for gamma radiation will be conducted on the accessible surfaces. Systematic sampling will be performed as specified in this TSP. Based on the scan data, biased samples will be collected at areas exceeding the survey unit mean plus 3 σ, where σ is the standard deviation of the gamma readings in the survey unit. At each sample location, a static measurement will be collected. At each systematic and biased location, soil samples will be collected from the soil surfaces. Static measurements will be collected using a Ludlum Model 2350-1 survey meter equipped with a Ludlum Model 44-10 2-inch by 2-inch NaI detector (or equivalent). Locations identified as having contamination present above the levels specified in Table 2-1 will be further characterized and subsequently remediated until the post-remediation confirmation readings do not indicate activity greater than the release criteria, as detailed in Section 3.0, and soil concentrations are comparable to background. If soil sampling results are below the release criteria provided in Table 2-1, the corresponding asphalt and concrete surfaces may be released for reuse, recycle, or disposal as non-LLRW. Otherwise, the Navy RASO will be notified and an approach for surveying the asphalt and concrete surfaces will be agreed upon before determining the disposition of these materials.

2.2.2 Vegetative Surfaces

The vegetative surfaces will be removed to 6 inches above the original ground surface. This material will be stockpiled on 10-mil plastic in the asphalt parking area north of the fencing bounding the original IR Site 6 area between Avenues I and M and 14th Street. Similar to the asphalt and concrete surfaces, the remaining vegetative/top soil surfaces up to the interface with the original soil surface associated with the salvage yard will be surveyed in 50-foot by 50-foot grids using TtEC's RASO-approved vehicle towed array system and/or a Ludlum Model 2350-1 survey meter with a Ludlum Model 44-10 2-inch by 2-inch NaI detector (or equivalent). Note that all 50-foot by 50-foot grids will be segregated pending soil sample results from beneath the corresponding vegetative/top soil surface. However, any vegetative/top soil exhibiting gamma readings exceeding the investigation level in a discrete area (i.e., less than 100 square feet) indicating a highly contaminated area or object (i.e., gamma readings exceeding the mean of the survey unit plus 3 σ) will be disposed of as LLRW.

Following vegetative/top soil removal, the underlying soil will be surveyed as a Class 1 area. The soil surface will be surveyed using TtEC's RASO-approved vehicle towed array system and/or a Ludlum Model 2350-1 survey meter equipped with a Ludlum Model 44-10 2-inch by 2-inch NaI detector (or equivalent). One hundred percent scan surveys for gamma radiation will be conducted on the accessible surfaces. Systematic sampling will be performed as specified in this TSP. Based on the scan data, biased samples will be collected at areas exceeding the survey unit mean plus 3 σ, where σ is the standard deviation of the gamma readings in the survey unit. At each sample location, a static measurement will be collected. At each systematic and biased location, soil samples will be collected from the soil surfaces. Static measurements will be collected using a Ludlum Model 2350-1 survey meter equipped with a Ludlum Model 44-10 2-inch by 2-inch NaI detector (or equivalent). Locations identified as having contamination present above the levels specified in Table 2-1 will be further characterized and subsequently remediated until the post-remediation confirmation readings do not indicate activity greater than the release criteria, as detailed in Section 3.0, and soil concentrations are comparable to background. If soil sampling results are below the release criteria provided in Table 2-1, the corresponding vegetative/top soil surfaces may be released for reuse, recycle, or disposal as non-LLRW. Otherwise, the Navy RASO will be notified and an approach for surveying the vegetative/top soil surfaces will be agreed upon before determining the disposition of these materials.

2.3 Avenue M

The portion of Avenue M located within IR Site 6 will be surveyed similar to the concrete surface within the original IR Site 6. The asphalt surface will be surveyed using a Ludlum Model 2360 survey meter equipped with a Ludlum Model 43-37 gas flow proportional detector (or equivalent) and/or a Ludlum 43-68 gas flow detector (or equivalent). One hundred percent scan surveys for alpha and beta radiation will be conducted on the accessible surfaces.

Systematic sampling will be performed as specified in this TSP. At each systematic (and biased) sample location, a static measurement and a swipe sample will be collected. Static measurements will be collected using a Ludlum Model 2360 survey meter equipped with a Ludlum Model 43-68 gas flow proportional detector (or equivalent). Locations identified as having contamination present above the levels specified in Table 2-1 will be further characterized and subsequently remediated until the post-remediation confirmation readings do not indicate activity greater than the release criteria, as detailed in Section 3.0.

3.0 REMEDIAL ACTION SUPPORT SURVEYS

If any areas identified by the survey data indicate elevated activity above the screening criteria specified in Table 2-1, these areas will be remediated to remove any fixed contamination exceeding the release criteria. This work will be accomplished by removing a thin layer of the surface material. It is important to note that fixed contamination methods can result in the creation of removable surface contamination. This creates a condition that may generate airborne radioactive material. Removal activities will be controlled in such a manner that generation of airborne radioactivity is greatly reduced. Air sampling will be performed to monitor and properly evaluate any resultant airborne radioactivity.

Remediation will be performed in accordance with the requirements of a Tetra Tech EC, Inc. Radiation Work Permit (RWP) and SOP-007, Decontamination of Equipment and Tools. Personnel performing the remediation will be required to wear protective coveralls, shoe covers, and gloves. A step-off pad with 55-gallon drums with plastic liners for waste will be placed at each entry point. To mitigate potential airborne contamination, a water surfactant will be sprayed on the affected areas prior to remediation.

Air monitoring will be performed during remediation using a low-volume continuous air monitor in accordance with SOP-009, Air Sampling and Sample Analysis. Air samples will be collected for the entire time that airborne causing remediation occurs, and for a minimum of 2 hours, to ensure that the minimum detectable concentration for 10 percent of the derived air concentration (DAC) for Ra-226 is met during air sampling. During the course of work, if an airborne concentration exceeds 10 percent of the DAC for Ra-226, ongoing activities will cease. The affected location will then be posted as an Airborne Radioactivity Area until the source of the airborne concentration is eliminated and levels are confirmed to be below 10 percent of the DAC, or increased controls are established in the applicable RWP.

The residual radioactivity on the concrete and asphalt surfaces will be removed by mechanically abrading the surface of the affected area. During the abrading, a high efficiency particulate air (HEPA) vacuum will be used to provide dust containment over the remediation area. To mitigate potential airborne contamination, a water surfactant will be sprayed on the affected area prior to remediation. During the removal, a HEPA vacuum will also be used to provide dust containment over the remediation area.

Residual radioactivity on the soil surfaces will be removed with hand tools (shovel, etc.) or a mini-excavator, depending on the extent of contamination. To mitigate potential airborne contamination, a water surfactant will be sprayed on the affected area prior to remediation.

A Radiological Control Technician will check the progress of the remedial actions periodically by scanning the area with a Ludlum Model 2360 survey meter with a Ludlum Model 43-68 gas-flow proportional detector (or equivalent). For the asphalt and concrete surfaces, large area wipes will also be collected throughout the remediation process to ensure removable contamination is contained.

Remediation activities will continue until the survey indicates that the screening criteria specified in Table 2-1 have been achieved. The release criterion for Ra-226 in soil, concrete, and asphalt is that it is comparable to background. For soil, the screening criterion is 1 picocurie per gram (pCi/g) above background. The screening criteria for the asphalt and concrete surfaces are 20 disintegrations per minute (dpm)/100 square centimeters (cm^2) alpha removable contamination, or 100 dpm/100 cm^2 alpha fixed contamination. Additionally, as radon progeny include beta-emitting radionuclides, any asphalt and concrete surfaces exceeding 1,000 dpm/ 100 cm^2 beta removable contamination or 5,000 dpm/100 cm^2 beta fixed contamination will be remediated. Any herculite or plastic sheeting used to protect against the spread of contamination to adjacent survey units will be disposed of as LLRW.

4.0 FINAL STATUS SURVEY DESCRIPTION

The FSS is being performed to assess whether residual activity (if present) has been removed to levels below the release criteria defined in Table 2-1. The FSS will be sufficient to recommend unrestricted radiological release of the site.

One hundred percent of the Class 1 soil survey units (Survey Units 01 through 04, 09, and 10) will be scanned using a Ludlum Model 2350-1 survey meter with a Ludlum Model 44-10 2-inch by 2-inch NaI detector (or equivalent). Alternatively, a RASO-approved drive-over-array system may be used as a replacement for the Ludlum Model 44-10 detector. Additional measurements and samples will be collected if investigation levels or release criteria are exceeded during the review of data. These areas will then be systematically sampled as indicated on the Class 1 survey unit figures provided in Appendix A. During the Class 1 soil survey activities, nine systematic gamma static measurements and solid samples will be collected. The approximate systematic locations are identified on soil survey unit plan view Figures A-3 through A-6 and Figures A-11 and A-12 provided in Appendix A.

Solid samples will be analyzed by gamma spectroscopy for Ra-226 by a Department of Defense Environmental Laboratory Accreditation Program accredited laboratory.

One hundred percent of the Class 1 concrete and asphalt survey units (Survey Units 05 through 08 and 11) will be scanned using a Ludlum Model 2360 survey meter with a Ludlum Model 43-37 gas flow proportional detector (or equivalent). Additional measurements and samples will be collected if investigation levels or release criteria are exceeded during the review of data. A minimum of 27 systematic static alpha/beta measurements and swipe samples will be collected in the Class 1 concrete and asphalt survey units. The approximate systematic locations are identified on the asphalt and concrete survey units plan view Figures A-7 through A-10 and Figure A-13 provided in Appendix A.

4.1 Release Criteria

The release criterion for Ra-226 in soil, concrete, and asphalt is that it is comparable to background. The screening criteria for the soil, concrete, and asphalt are provided in Table 2-1. The site will be modeled using residual radionuclide concentrations to evaluate total dose and risk.

4.2 Reference Area

Prior to performing the survey activities, material-specific background reference areas will be established for the soil, asphalt, and concrete radiological survey activities. Non-radiologically impacted site background reference areas with similar physical, chemical, geological, radiological, and biological characteristics as the site being evaluated will be selected. For the soil surfaces, the reference background area and soil sample results provided in the report titled Analysis of Gamma Survey and Radium-226 Soil Concentration Data at the Treasure Island Site-Wide Background Areas and the Area 7 Background Reference Area (Shaw 2012) will be used.

4.3 Investigation Level

The initial investigation level for alpha surveys will be areas identified by two or more alpha counts over the predetermined scan interval followed by two or more alpha counts after pausing over the same area when using a large area detector (Ludlum Model 43-37 series or equivalent) with background count rates between 5 to 10 counts per minute. Note that in cases where several contiguous areas are identified with two or more alpha counts, single static measurement investigations for each contiguous area may be conducted with Navy RASO concurrence. Additionally, in cases where elevated alpha counts are identified in many areas as a result of elevated background conditions, such as those due to radon progeny, the investigation level may be adjusted with Navy RASO concurrence. However, all areas exceeding two or more alpha counts during the pause will be identified.

When using a handheld detector (Ludlum Model 43-68 or equivalent) that has a background count rate ranging from less than 1 to 3 counts per minute for alpha surveys, the investigation level will be one or more alpha counts over the predetermined scan interval followed by one or more alpha counts after pausing over the same area. The investigation level for beta surveys will be 4,500 dpm per detector window area for 43-37 series detectors. Biased static measurements will be collected in areas where investigation levels have been exceeded. The investigation levels for removable contamination are 20 dpm/100 cm^2 alpha and 1,000 dpm/100 cm^2 beta. These levels are consistent with the release criteria presented in Table 2-1. For gamma surveys, the investigation level will be established at the survey unit mean plus 3-σ, where σ is the standard deviation of the gamma readings in the survey unit.

4.4 Survey Units

Survey Units 01 through 10 are considered Class 1 areas that require 100 percent scan survey as recommended in MARSSIM guidance Section 8.5.3 (DoD et al. 2000). The locations of the Class 1 survey units within IR Site 6 are shown on Figure A-2. The survey unit layouts are shown on Figures A-3 through A-13 in Appendix A.

Survey unit boundaries may be adjusted based on actual field conditions with the concurrence of the Radiation Safety Officer Representative. Additional survey units or changes to existing survey units will be documented in the FSS Report.

Each Class 1 survey unit will contain systematic data collection locations. At each systematic sample location, a direct surface measurement, and soil or swipe survey samples will be obtained. Swipe survey samples will be analyzed in accordance with the SOPs. The number of systematic locations has been determined in Section 4.5 to be a minimum of 27 for concrete and asphalt surfaces, and 9 for soil areas. Using a random start point, the systematic data collection locations have been laid out in a triangular grid pattern for each survey unit using the computer process provided by Visual Sample Plan (Matzke et al. 2010). Locations for the systematic data collection are shown on Figure A-3 through A-13 in Appendix A.

4.5 Establishing the Number of Measurements

Since the contaminants may be present in the background, *N* is calculated in the manner specified for the Wilcoxon Rank-Sum test (Equation 5-2 from the Radiological Management Plan):

Equation 5-2 from the Radiological Management Plan (TtEC 2014a)

$$N = \left\{ \frac{\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2}{3\left(P_r - 0.5\right)^2} \right\} (1.2)$$

Where:

$Z_{1-\alpha}$ = Type I decision error level as determined from MARSSIM (1.645)

$Z_{1-\beta}$ = Type II decision error level as determined from MARSSIM (1.645)

P_r = random measurement probability, which is based on relative shift discussed in Section 4.5.3

1.2 = factor for oversampling to account for missing or unusable data

The second term in the equation increases the number of data points by 20 percent. The value of 20 percent was selected to account for a reasonable amount of uncertainty in the parameters used to calculate *N* and still allow flexibility to account for some lost or unusable data. While this 20 percent factor assists in meeting all data quality objectives (DQOs) as stated in Table 4-1, it is not required during the data quality assessment to demonstrate compliance with the stated objectives of the statistical tests. The actual number of measurements required for each survey unit will be calculated for the final report.

P_r in Equation 5-2 from the Radiological Management Plan is based on the relative shift. The relative shift is equal to Δ/σ, where Δ is equal to [derived concentration guideline level (DCGL) − lower boundary of the gray region (LBGR)], and σ is an estimate of the standard deviation of the measured values in a survey unit.

4.5.1 LBGR Determination

The LBGR is the net median concentration of the contaminant in the survey unit. Since this value is unknown, MARSSIM (DoD et al. 2000) suggests using a value for the LBGR of ½ DCGL for planning purposes. However, once the net median concentration activity in the survey unit is established, this value will be used as a ratio to the lowest DCGL for the decay method to determine the LBGR. Equation 6-7 from the Radiological Management Plan gives the method used to determine the LBGR:

Equation 6-7 from the Radiological Management Plan (TtEC 2014a)

$$LBGR = \frac{C_1}{DCGL_1} + \frac{C_2}{DCGL_2} + \frac{C_3}{DCGL_3} + ... + \frac{C_i}{DCGL_i} \leq 1$$

Where:

C_i = concentration of radionuclide "i"

$DCGL_i$ = DCGL of radionuclide "i"

For planning purposes, the LBGR will administratively be set to ½ the DCGL, or at a value of 50 dpm/100 cm^2 for surfaces and 0.85 based on a release criterion of 1 pCi/g above a background of 0.7 pCi/g.

4.5.2 Standard Deviation

As Ra-226 is the only radionuclide of concern, and a typical standard deviation for alpha measurements on concrete is 10 dpm/100 cm^2 and 0.2 pCi/g for soil, these values will be used for computing purposes.

4.5.3 Relative Shift

The relative shift is equal to Δ/σ, where Δ is equal to [wide-area DCGL ($DCGL_W$) − LBGR] and σ is an estimate of the standard deviation of the measured values in a survey unit (or for planning purposes from the background area). For soil, the relative shift can be calculated as shown in Equation 5-1 from the Radiological Management Plan:

Equation 5-1 from the Radiological Management Plan (TtEC 2014a)

$$\frac{\Delta}{\sigma} = \frac{DCGL_W - LBGR}{\sigma} = \frac{1.7 - 0.85}{0.2} = 4.25$$

Using this Δ/σ value of 4.25 from Table 5.1 of MARSSIM, P_r was determined to be 1.

For concrete and asphalt, the relative shift can be calculated as shown in Equation 5-1 from the Radiological Management Plan:

Equation 5-1 from the Radiological Management Plan (TtEC 2014a)

$$\frac{\Delta}{\sigma} = \frac{DCGL_W - LBGR}{\sigma} = \frac{100 - 50}{10} = 5$$

Using this Δ/σ value of 5 from Table 5.1 of MARSSIM, P_r was determined to be 1.

4.5.4 Calculation of *N*

As P_r for both soil and concrete determined to be 1, *N* is calculated using Equation 5-2 from the Radiological Management Plan as follows:

Where:

Type I decision error level (MARSSIM Table 5.2): 1.645
Type II decision error level (MARSSIM Table 5.2): 1.645
Random measurement probability (MARSSIM Table 5.1): 1

$$17.3 = \left\{ \frac{(1.645 + 1.645)^2}{3(1 - 0.5)^2} \right\} (1.2)$$

N for surveys is calculated as a minimum of 17.3 total data collection locations. Rounding this number up to an even number would equate to 9 from each survey unit and 9 from the reference area, for a total of 18. The value of 9 for asphalt and concrete surfaces is increased to 27 within each survey unit, in accordance with Navy RASO guidance concerning alpha scan guidance based on the maximum alpha surface contamination guidelines provided in Atomic Energy Commission Regulatory Guide 1.86 to provide additional assurance that sufficient data have been collected. However, the number of data collection locations within the reference area has been increased to a total of 20. Figures A-7 through A-10 and Figure A-13 indicate the approximate systematic measurement locations for asphalt and concrete survey units. Figures A-3 through A-6 and Figures A-11 and A-12 provide the approximate systematic measurement locations for soil survey units.

Although not initially designated as an FSS, the survey was designed so that if no radioactive contamination was found above the established release criteria, this survey could be used as an FSS, in accordance with MARSSIM (DoD et al. 2000). To maintain the potential for an FSS, data will be continuously analyzed to determine the relationship between each survey unit and the reference area.

4.6 Alpha and Beta Scan Measurements

Scan measurements are performed to identify areas of radioactivity that exceed an action level within the survey unit. Alpha (α) and beta (β) scans will be effective for identifying elevated concentrations of Ra-226 in the concrete and asphalt surfaces. One hundred percent of accessible surface areas in the Class 1 survey units will be scanned with the Ludlum Model 43-37, 43-37-1, or 43-68 gas flow proportional detectors coupled to a Ludlum 2360 data logger (or equivalent). Instrumentation may be supported by global positioning system (GPS) equipment to ensure 100 percent scan of the Class 1 survey unit and that the scan speed established in the TSP is met in the field. GPS with real-time kinematic positioning capabilities will provide fixed solution accuracy (1 to 5 centimeters) for detector positioning.

4.6.1 Alpha Scan Measurements

4.6.1.1 Large Area Detectors (Model 43-37, 43-37-1, or equivalent)

The alpha count rate on various surfaces typically averages less than 10 counts per minute (cpm) with a Model 43-37 or 43-37-1 (or equivalent) detector. Therefore, alpha scan speeds will be determined using Equation 7-4 from the Radiological Management Plan (TtEC 2014a).

Equation 7-4 from the Radiological Management Plan (TtEC 2014a)

$$P(n \geq 2) = 1 - \left[1 + \frac{(GE + B)t}{60}\right]\left[e^{\frac{-(GE+B)t}{60}}\right]$$

Where:

$P(n \geq 2)$	=	probability of getting two or more counts during the time interval *t*(%)
t	=	time interval (seconds) = 4
G	=	$DCGL_W$ × area factor (dpm) = 300
E	=	detector efficiency (4π) = 0.10
B	=	observed background count rate (cpm) = 10
$P(n \geq 2)$	=	74.52 percent at a scan speed of 4 centimeters per second (cm/s)

The scan surveys will be performed using a Ludlum Model 43-37 (or equivalent) detector. The detector position will be adjusted so that the detector window is approximately one-quarter inch from the building surfaces. The surveyor will move the detector at a scan speed of 4 cm/s while maintaining audio and visual observation of the instrument response. If the surveyor observes two or more counts during a scan interval (approximately 4 seconds), the surveyor will pause the detector movement for 4 seconds to obtain additional data. If no additional counts are noticed during the 4-second observation, the surveyor can continue the scan survey. Conversely, if additional counts are noticed during the 4-second observation, the surveyor will mark the area for potential further investigation and subsequent biased measurements using a 126-cm^2 or smaller detector to locate and properly quantify any areas of elevated activity.

4.6.1.2 Small Area Detectors (Model 43-68 or equivalent)

The alpha count rate on various surfaces typically averages less than 1 to 3 cpm with a Model 43-68 detector. When using a 126-cm^2 or smaller detector, scanning for alpha emitters differs in that the expected background response of most alpha detectors is very close to zero. Since the amount of time a contaminated area is under the probe varies, and the background count rate of some alpha instruments is less than 1 cpm, it is not reasonable to determine a fixed minimum detectable concentration (MDC) for scanning. Instead, it is more practical to determine the probability of detecting an area of contamination at a predetermined derived concentration guideline level for given scan rates.

For alpha survey instrumentation with backgrounds ranging from less than 1 to 3 cpm, a single count provides a surveyor sufficient cause to stop and investigate further. Assuming this to be true, the probability of detecting given levels of alpha surface contamination can be calculated by use of Poisson summation statistics.

Given a known scan rate and a surface contamination release limit, the probability of getting a second count from a 300 dpm source is calculated using Equation 7-2 from the Radiological Management Plan (TtEC 2014a):

Equation 7-2 from the Radiological Management Plan (TtEC 2014a)

$$P(n \geq 1) = 1 - e^{\frac{-GEd}{60v}}$$

Where:

$P(n \geq 1)$	=	probability of observing a single count = 83.26 percent
G	=	contamination activity dpm = 300
E	=	detector efficiency (4π) = 0.10
d	=	width of detector in direction of scan (centimeters) = 14.3
v	=	scan speed (cm/s) = 4

Once a count is recorded and the guideline level of contamination is present, the surveyor will stop and wait until the probability of getting another count is at least 90 percent. This time interval can be calculated using Equation 7-3 from the Radiological Management Plan (TtEC 2014a):

Equation 7-3 from the Radiological Management Plan (TtEC 2014a)

$$t = \frac{13,800}{CAE}$$

Where:

t	=	time period for static count(s) = 3.65
C	=	contamination guideline (dpm/100 cm^2) = 300
A	=	physical probe area (cm^2) = 126
E	=	detector efficiency (4π) = 0.10

Using the above equations from the Radiological Management Plan and Chapter 6 of MARSSIM (DoD et al. 2000), the probability of detecting 300 dpm/100 cm^2 alpha at a scan speed of 4 cm/s with a time period of 4 seconds for a static count is 83.26 percent.

Scan speeds may be adjusted based on the specific parameters for instruments in use.

4.6.2 Beta Scan Measurements

4.6.2.1 Large Area Detectors (Model 43-37, 43-37-1, or equivalent)

The minimum number of net source counts in the scan interval can be arrived at by multiplying the square root of the number of background counts (in the scan interval) by the detectability value associated with the desired performance (as reflected in d') as shown in Equation 7-5 from the Radiological Management Plan (TtEC 2014a):

Equation 7-5 from the Radiological Management Plan (TtEC 2014a)

$$MDCR = \mathrm{d}' \sqrt{\mathrm{b}_i}\left(\frac{60}{i}\right)$$

Where:

d'	=	index of sensitivity (α and β errors [performance criteria])
b_i	=	number of background counts in scan time interval (count)
i	=	scan or observation interval (seconds)

For beta scans:

d'	=	3.28
b_i	=	33.3 counts (based on a background of 500 cpm)
i	=	15.90 cm / 4 cm/s = 4 seconds

Beta scan minimum detectable count rate (MDCR) = 284.06 cpm at a scan speed of 4 cm/s.

The scan MDC is determined from the MDCR by applying conversion factors that account for detector and surface characteristics and surveyor efficiency. As discussed below, the MDCR accounts for the background level, performance criteria (d'), and observation interval. The observation interval during scanning is the actual time that the detector can respond to the contamination source. This interval depends on the scan speed, detector size in the direction of the scan, and area of elevated activity. The scan MDC for structure surfaces is calculated using Equation 7-6 from the Radiological Management Plan (TtEC 2014a):

Equation 7-6 from the Radiological Management Plan (TtEC 2014a)

$$Scan\ MDC = \frac{MDCR}{\sqrt{p}\ \varepsilon_i \varepsilon_s \frac{W_A}{100\ cm^2}}$$

Where:

MDCR is discussed above

p	=	surveyor efficiency factor
ε_i	=	instrument efficiency (counts per particle)
ε_s	=	contaminated surface efficiency (particles per disintegration)
W_A	=	area of the detector window (cm^2)

For beta scans:

$MDCR$	=	284.06
p	=	0.50
ε_i	=	0.4084
ε_s	=	0.25
W_A	=	821

Beta scan MDC = 479.24 dpm/100 cm^2 at a scan speed of 4 cm/s.

4.7 Alpha and Beta Static Measurements

Alpha and beta static measurements will be obtained from the locations identified in Appendix A. Additional measurements may be collected if radiation readings exceeding the investigation level are identified while performing the scan surveys. Ludlum Model 43-68 gas-flow proportional detectors coupled to Ludlum Model 2360 data loggers (or equivalent) will be used to perform alpha and beta static measurements. Note that all alpha and beta static measurements exceeding investigation levels should have corresponding notes on the survey sheets annotating the investigative action taken (sample taken, surveyed with different instrument type, etc.).

4.7.1 Alpha Static Measurements

The MDC for alpha measurements is calculated using Equation 7-7 from the Radiological Management Plan (TtEC 2014a):

Equation 7-7 from the Radiological Management Plan (TtEC 2014a)

$$MDC = \frac{3 + 4.65\sqrt{R_B T_B}}{\varepsilon_s \varepsilon_i \frac{W_A}{100} T_B}$$

Where:

3 + 4.65	=	constant factor provided in MARSSIM
R_B	=	background count rate = 1 cpm
T_B	=	background count time = 2 minutes
ε_i	=	instrument efficiency = 0.4
ε_s	=	surface efficiency factor = 0.25
W_A	=	probe area size = 126 cm^2

The calculated MDC (based on preliminary measurements) for alpha contamination is 37.99 dpm/100 cm^2, using a 2-minute static counting time. Counting time may be increased as necessary to provide a sufficient static MDC for Ra-226 below the release criterion (Table 2-1).

The specified count times are based on the MDC formula, Equation 7-7 from the Radiological Management Plan (TtEC 2014a). The count times are useful in determining an instrument's ability to meet the required MDC. However, empirically derived values will provide a more accurate assessment of the MDC for a specified count time as recommended by MARSSIM (DoD et al. 2000). Empirical values will be determined at NAVSTA TI in conjunction with reference area measurements. With concurrence of the Navy RASO, count times determined based on empirical data will be used for static survey measurements.

4.7.2 Beta Static Measurements

For the Ludlum 43-68, the MDC equation becomes:

$$MDC = \frac{3 + 4.65\sqrt{R_B T_B}}{\varepsilon_s \varepsilon_i \frac{W_A}{100} T_B}$$

Where:

3 + 4.65	=	constant factor provided in MARSSIM
R_B	=	background count rate = 500 cpm
T_B	=	background count time = 2 minutes
ε_i	=	instrument efficiency = 0.4
ε_s	=	surface efficiency factor = 0.25
W_A	=	probe area size = 126 cm^2

The calculated MDC (based on preliminary measurements) for beta contamination is 595.4 dpm/100 cm^2, using a 2-minute static counting time. Counting time may be increased as necessary to maintain the MDC below the Table 2-1 limits.

Alpha and beta measurements are recorded at the same time with a Ludlum 2360 data logger. Therefore, the count time for Ra-226 with the Ludlum 43-68 detector in the static mode will be 2 minutes.

The specified count times are based on the MDC formula, Equation 7-7 from the Radiological Management Plan (TtEC 2014a). The count times are useful in determining an instrument's ability to meet the required MDC. However, empirically derived values will provide a more accurate assessment of the MDC for a specified count time as recommended by MARSSIM (DoD et al. 2000). Empirical values will be determined at NAVSTA TI in conjunction with reference area measurements. With concurrence of the Navy RASO, count times determined based on empirical data will be used for static survey measurements.

4.8 Gamma Scans

One hundred percent of the Class 1 survey units will be scanned with a RASO-approved drive-over array system or using a Ludlum Model 2350-1 survey meter with a Ludlum 44-10 2-inch by 2-inch NaI detector as detailed in the Radiological Management Plan (TtEC 2014a). Gamma scans by the drive-over array or survey instruments will be logged and submitted with the final report. If a Ludlum 2350-1 with a 44-10 2-inch by 2-inch NaI detector is used, scans will be performed at a rate of approximately 0.5 meter per second (6-second scan observation) with the detector held approximately 10 centimeters (4 inches) above the ground. The detector will be moved back and forth across the travel path while scanning, producing a serpentine scan pattern. Using a RASO-approved towed array for scanning will result in an MDC of less than 1.0 pCi/g of ^{226}Ra. Instrumentation may be supported by GPS equipment to ensure 100 percent scan of the Class 1 survey unit and that the scan speed established in the TSP is met in the field.

4.8.1 MDCR for Gamma Surveys (2-inch by 2-inch NaI Probe)

The MDCR is the minimum detectable number of net source counts in the scan interval, for an ideal observer, that can be arrived at by multiplying the square root of the number of background counts (in the scan interval) by the detectability value associated with the desired performance (as reflected in d'), as shown in Equation 7-5 from Radiological Management Plan (TtEC 2014a):

Equation 7-5 from the Radiological Management Plan (TtEC 2014a)

$$MDCR = d' \sqrt{b_i} \left(\frac{60}{i} \right)$$

Where:

MDCR	=	minimum detectable count rate
d'	=	index of sensitivity (α and β errors) = 3.28
b_i	=	number of background counts in scan time interval = 96.77 cpm
i	=	scan or observation interval = 1 second

For this calculation, the observed background count rate of 5,806 cpm is used. It should be noted that a typical source will remain under the NaI probe for 1 second during the scan; therefore, the average number of background counts in the observation interval is 96.77 [b_i = 5,806 × (1/60)]. The required rate of true positives is 95 percent, and the rate of false positives is 5 percent. From Table 6.5 of MARSSIM (DoD et al. 2000), the value of *d'*, representing this performance goal, is 3.28. Using these inputs, the MDCR is 1,935.92 cpm.

4.8.2 MDCR and Use of Surveyor Efficiency, Gamma (2-inch by 2-inch NaI Probe)

The MDCR calculated assuming a surveyor efficiency ($MDCR_{SURVEYOR}$) can be calculated assuming a surveyor efficiency (*P*) of 0.5 and the observed background count rate of 5,806 cpm, using Equation 7-9 from the Radiological Management Plan (TtEC 2014a):

Equation 7-9 from the Radiological Management Plan (TtEC 2014a)

$$MDCR_{SURVEYOR} = \frac{MDCR}{\sqrt{P}} = \frac{1{,}935.92}{\sqrt{0.5}} = 2{,}737.81\,cpm$$

4.9 Static Gamma Measurements

Static gamma measurements will be collected at the specified systematic locations in the survey unit using a Ludlum Model 2350-1 survey meter with a Ludlum 44-10 2-inch by 2-inch NaI detector. Additional biased measurements may be collected if elevated gamma scan survey results identify measurements above the investigation level. The gamma measurements will be collected in accordance with SOP-001, Radiation and Contamination Surveys.

For gamma surveys, the MDC is calculated in cpm. Equation 7-12 from the Radiological Management Plan (TtEC 2014a) is used to calculate the MDC:

Equation 7-12 from the Radiological Management Plan (2014a)

$$MDC = \frac{3 + 4.65\sqrt{R_B\, T_B}}{T_B}$$

Where:

3+4.65	=	constant factor provided in MARSSIM (DoD et al. 2000)
R_B	=	background count rate (cpm) = 5,806
T_B	=	background counting time (minute) = 1

Using the inputs observed in the reference area (listed above at 5,806 cpm) in Equation 7-12, the calculated MDC for the Ludlum Model 2350-1 with a 44-10 2-inch by 2-inch NaI detector is 357.32 cpm.

4.10 Exposure/Dose Rate Measurements

Before any MARSSIM based surveys are conducted, a general area gamma exposure/dose rate survey will be conducted of the impacted areas for safety and radiological posting purposes, as well as to identify any areas with comparatively elevated gamma exposure rates. Ludlum Model 19, Bicron MicroRem, or equivalent scintillation detectors will be used to perform the measurements. The measurements will be taken with the instrument 1 meter from the ground surface.

4.11 Media Samples

Swipe surveys will be conducted at each of the specified systematic locations for each survey unit. Additional samples may also be collected based on scan survey results exceeding the investigation level. All swipe surveys will be counted on a Protean WPC 1050 gas flow proportional gross alpha and beta radiation counter (or equivalent). If the Protean is inoperable or unavailable for use, swipe samples may also be screened using a Ludlum 2929 or 3030 scaler rate meter with a Ludlum 43-10-1 detector (or equivalent). Swipe surveys will be performed and documented in accordance with SOP-001, Radiation and Contamination Surveys.

When applicable, general area removable contamination will be assessed using Masslinn® cloths and monitoring the cloths with a Ludlum 43-68 detector coupled to a Ludlum 2360 data logger. The detector will be operated on the alpha plus beta plateau. Areas with a Masslinn cloth indicating any increase in activity will be rewiped with another Masslinn cloth to determine the specific area that contains the removable contamination.

Solid soil samples will be collected at the systematic and biased (when used) sampling locations and analyzed by gamma spectroscopy. Count times for gamma spectroscopy may be increased as directed by the laboratory manager to provide for minimum detectable activities that are below the release criteria. One hundred percent of final systematic solid soil samples analyzed at the on-site laboratory (by gamma spectroscopy analysis) will be analyzed using the definitive method. Acceptable quality control parameters are listed in Worksheet 28 of the Sampling and Analysis Plan, which is Attachment 1 to the Work Plan (TtEC 2014a).

4.12 Dose Modeling in Support of Unrestricted Release

The intent of the IR Site 6 FSS is to achieve unrestricted release for the site. To accomplish this goal, it is necessary to provide a means for calculating residual dose to the critical group; the resident farmer and residential scenarios in RESRAD and RESRAD-BUILD, respectively, were selected. The modifications to the default residential farmer scenario for RESRAD will be to use the actual surface area of the survey unit, change the distance of the length parallel to the aquifer to the square root of the actual surface area for the survey unit, and use the net concentrations above background. The modifications to the default scenario presented in RESRAD-BUILD will be to use the net mean concentrations for Ra-226 above background, use the actual surface area for the survey unit, and change the removable fraction to 20 percent.

After the residual dose is determined, the Department of the Navy will also determine the excess lifetime cancer risk to the critical group. These values will be provided in the final report.

5.0 QUALITY CONTROL

The DQOs for the survey are provided in Table 4-1.

Definable features of work (DFWs) establish the measures required to verify both the quality of work performed and compliance with project requirements. The DFW for this task is radiological surveys and sampling. Description of this DFW and the associated phases of quality control are presented in Table 5-1.

6.0 ENVIRONMENTAL PROTECTION

The environmental protection-driven requirements have been addressed in the Environmental Protection Plan (TtEC 2014a). No additional requirements are necessary.

7.0 REFERENCES

DoD (Department of Defense), Department of Energy, Nuclear Regulatory Commission, and U.S. Environmental Protection Agency. 2000. Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575, Revision 1. August.

Gilbane (Gilbane Federal). 2014. Internal Draft Radiological Scoping Survey Report, Installation Restoration Site 12 and Selected Transportation Routes, Former Naval Station Treasure Island, San Francisco, California. May.

Matzke et al. 2010. Visual Sample Plan. Upgrade version 6.0 released June 2010. Pacific Northwest National Laboratory. June.

Shaw (The Shaw Group). 2012. Analysis of Gamma Survey and Radium-226 Soil Concentration Data at the Treasure Island Site-Wide Background Areas and the Area 7 Background Reference Area, Naval Station Treasure Island, San Francisco, California. April 23.

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TtEC (Tetra Tech EC, Inc.). 2013. Radiological Field Activities Summary Report UST/AST 240 Corrective Action, Naval Station Treasure Island, San Francisco, California. October.

—————. 2014a. Characterization and Remedial Support Survey Work Plan, Radiological Characterization, Remediation, and Final Status Surveys at Installation Restoration Site 6, Naval Station Treasure Island, San Francisco, California. August.

—————. 2014b. Accident Prevention Plan/Site Safety and Health Plan, Radiological Characterization, Remediation, and Final Status Surveys at Installation Restoration Site 6, Naval Station Treasure Island, San Francisco, California. January.

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TABLES

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TABLE 2-1

INSTALLATION RESTORATION SITE 6
PRIMARY RADIATION PROPERTIES AND SCREENING CRITERIA
FOR RADIONUCLIDES OF CONCERN

Radionuclide	Primary Radiation Properties		Release Criteria		
			Materials, Equipment, and Wastes		Release Criteria for Residential Reuse Solid Samples[b] (pCi/g)
	Half-life	Type	Total Surface Activity[a]	Removable Activity[a]	
Ra-226	1,600 y	Alpha Gamma	100	20	1
Ra-226 progeny	Variable	Beta	5,000	1,000	1

Notes:
[a] Units are disintegrations per minute per 100 square centimeters.
[b] The release criterion for Ra-226 is indistinguishable from background with a screening criterion of 1 picocurie per gram above background.

Abbreviations and Acronyms:
pCi/g – picocuries per gram
Ra-226 – radium-226
y – year

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TABLE 4-1

SUMMARY OF DATA QUALITY OBJECTIVES

STEP 1	STEP 2	STEP 3	STEP 4	STEP 5	STEP 6	STEP 7
State the Problem	**Identify the Goal of the Study**	**Identify Information Inputs**	**Define the Boundaries of the Study**	**Develop the Analytical Approach**	**Specify Performance or Acceptance Criteria**	**Develop the Plan for Obtaining Data**
IR Site 6 is an area potentially impacted by prior stockpiling of radiologically impacted soil and salvage yard operations. The radionuclide of concern is Ra-226. It must be determined if the site-specific release criterion for this radionuclide has been met or if remediation is warranted.	The primary use of the data expected to result from completion of this TSP is to support the Final Status Survey of IR Site 6. Therefore, the decision to be made can be stated as "Do the results of the survey meet the release criteria?"	Radiological surveys required to support the Final Status Survey of IR Site 6 will include: • 100 percent scan surveys of Class 1 areas • A minimum of 27 systematic static measurements in Class 1 asphalt and concrete areas and 9 in Class 1 soil areas • One swipe survey at each asphalt and concrete systematic sample location • Static and swipe survey measurements at biased asphalt and concrete locations • Nine soil samples collected in Class 1 soil areas	The lateral and vertical spatial boundaries for this survey effort are confined to the interior of IR Site 6, not including Avenue M and the access road to the former parking and storage area, as shown on the figures in Appendix A.	If the concentration of radioactivity on site surfaces is less than the release criteria, then no further measurements are required. If the results of the survey exceed the release criteria, then the site will be further investigated.	Limits on decision errors are set at 5 percent as specified in the Radiological Management Plan (TtEC 2014a).	Operation details for the radiological survey process have been developed. The theoretical assumptions are based on guidelines contained in MARSSIM (DoD et al. 2000). Specific assumptions regarding types of radiation measurements, instrument detection capabilities, quantities and locations of data to be collected, and investigation levels are contained in this TSP and the Radiological Management Plan (TtEC 2014a).

Abbreviations and Acronyms:
IR – Installation Restoration
MARSSIM – Multi-Agency Radiation Survey and Site Investigation Manual
Ra-226 – radium-226
TSP – Task-specific Plan

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TABLE 5-1

DEFINABLE FEATURES OF WORK FOR RADIOLOGICAL SURVEYS

ACTIVITY	PREPARATORY (Prior to initiating survey activity)	DONE	INITIAL (At outset of survey activity)	DONE	FOLLOW-UP (Ongoing during survey activity)	DONE
Radiological surveys and sampling	• Verify that an approved TSP is in place. • Verify that the Remedial Project Manager, ROICC, and the Caretaker Site Office are notified about mobilization. • Verify that an approved RWP, if required, is available and has been read and signed by assigned personnel. • Verify that the Radiological Management Plan (TtEC 2014a), APP/SSHP (TtEC 2014b), and TSP have been reviewed. • Verify that personnel assigned are trained and qualified. • Verify that personnel have been given an emergency notification procedure. • Verify that workers assigned dosimetry have completed NRC Form 4. • Verify that relevant SOPs and/or manufacturers' instructions are available and have been reviewed for equipment to be used. • Verify that equipment is on-site and in working order (initial daily check).		• Verify that radiological instruments are as specified in the Radiological Management Plan (TtEC 2014a) and TSP. • Inspect Training Records. • Verify that a qualified RCT and SSHO are present in the active work areas. • Verify that reference area measurements have been obtained in accordance with the Radiological Management Plan (TtEC 2014a) and this TSP. The same survey methodology and instruments used to collect the background data will be used to perform measurements within survey units. • Verify that daily checks were performed on all survey instruments. • Verify that instrument calibration and setup are current. • Verify that required dosimetry is being worn. • Verify that field logbooks, chain-of-custody documents, and proper forms are in use. • Verify that samples and measurements are being collected in accordance with the TSP, Radiological Management Plan (TtEC 2014a), and applicable SOPs. • Verify the sample handling is in accordance with the Radiological Management Plan (TtEC 2014a) and applicable SOPs. • Verify scan speeds are being met as		• Verify that the site is properly posted and secured, if necessary. • Conduct ongoing inspections of material and equipment. • Verify that a qualified RCT and SSHO are present at active work areas. • Verify that daily instrument checks were obtained and documented. • Verify the survey results were documented. • Verify that personnel have read and signed the revised RWP, if revision is required. • Inspect chain-of-custody and survey logs for completeness. • Verify the survey activities conform to the TSP. • Verify that survey instruments are recalibrated after repairs or modifications. • Verify that site activities are being photographed. • Verify that survey documentation is reviewed by the RSOR. • Verify scan speeds are being met as specified in the TSP.	

TABLE 5-1

DEFINABLE FEATURES OF WORK FOR RADIOLOGICAL SURVEYS

ACTIVITY	PREPARATORY (Prior to initiating survey activity)	DONE	INITIAL (At outset of survey activity)	DONE	FOLLOW-UP (Ongoing during survey activity)	DONE
			specified in the TSP (i.e., survey units and lanes will be laid out accordingly). Marking may be made every 10 feet. RCTs will be required to take a minimum of 20 readings every 10 feet (probe ~ 0.52 foot). Once the data are turned over to the data manager, calculations will be performed to ensure sufficient readings have been taken and that the estimated scan speed has been met. The estimated speed in centimeters per second is determined by taking the survey unit in square centimeters and dividing it by the detector probe length, number of measurements, and the scan interval. GPS may also be used to ensure 100 percent scan of the survey unit and assist in determining the estimated scan speed.			

Abbreviations and Acronyms:
APP – Accident Prevention Plan
GPS – global positioning system
NRC – Nuclear Regulatory Commission
RCT – Radiation Control Technician
ROICC – Resident Officer in Charge of Construction
RSOR – Radiation Safety Officer Representative
RWP – Radiation Work Permit
SOP – Standard Operating Procedure
SSHO – Site Safety and Health Officer
SSHP – Site Safety and Health Plan
TSP – Task-specific Plan

APPENDIX A

FIGURES FOR INSTALLATION RESTORATION SITE 6 SURVEYS

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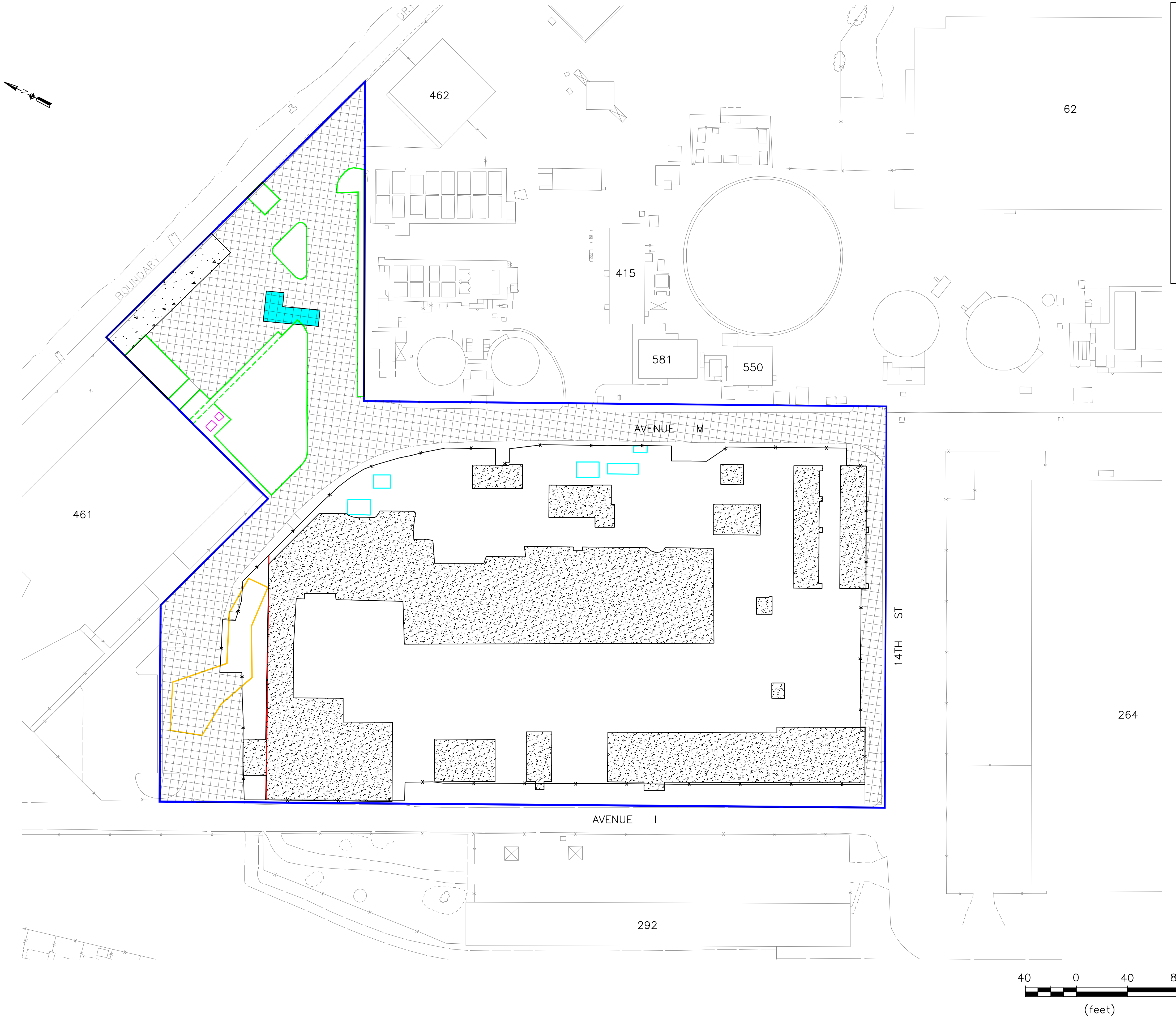
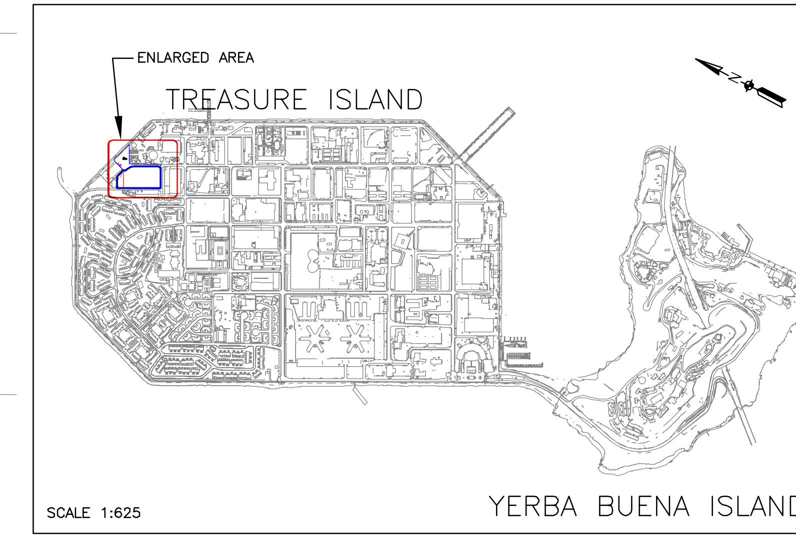




NOTE:

1. REMAINDER OF RCA BOUNDED BY EXISTING FENCING.

LEGEND:

RCA	RADIOLOGICALLY CONTROLLED AREA
	ASPHALT
	CONCRETE
	SUMPS/PITS
	CONCRETE AGGREGATE
	UTILITY BOX
	FORMER BUILDING 327
	IR SITE 6 BOUNDARY
	FORMER UST/AST 240 AREA
	NORTHWESTERN RCA BOUNDARY (SEE NOTE 1)
— x —	FENCE
	VEGETATION

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CALIFORNIA

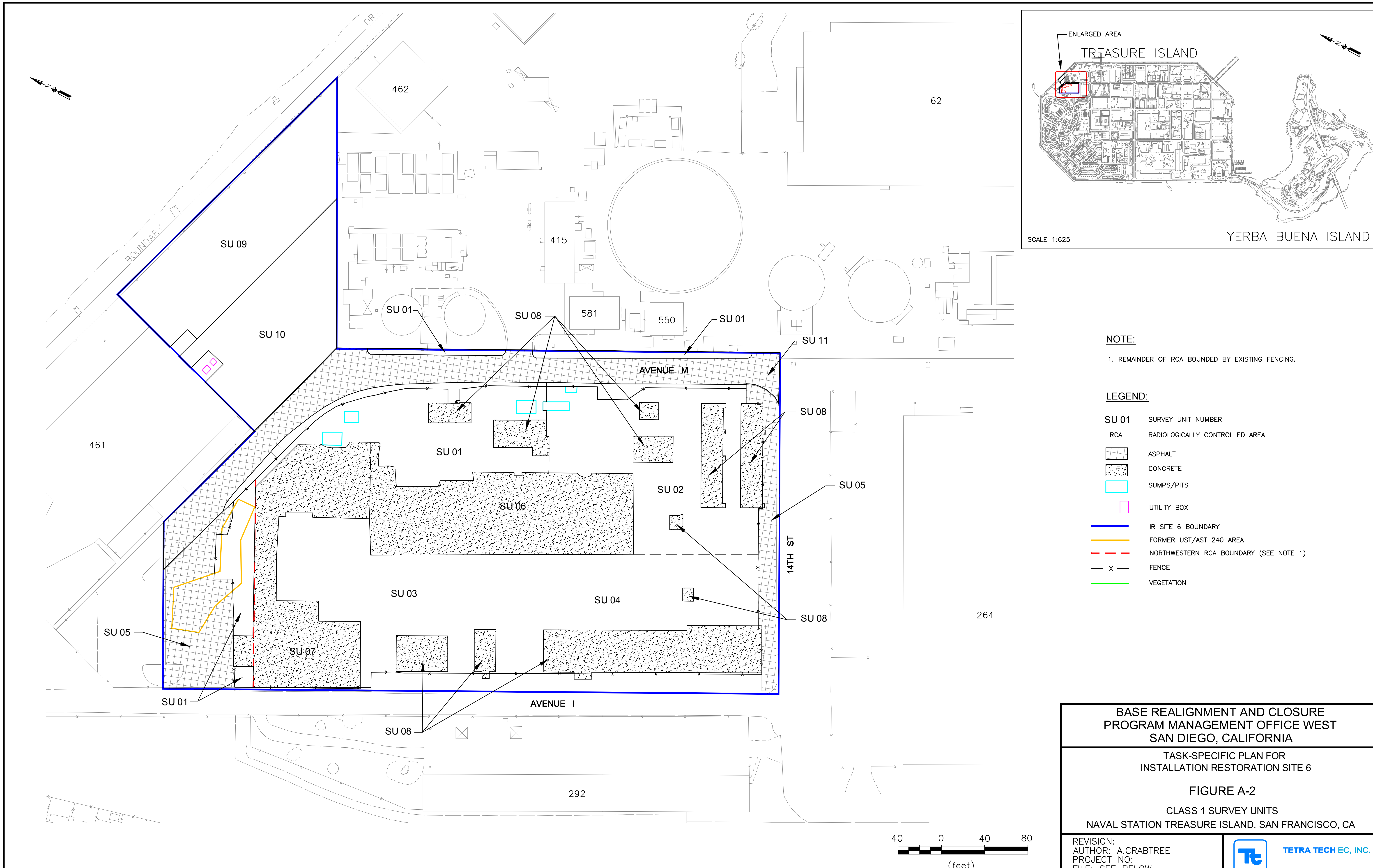
TASK-SPECIFIC PLAN FOR
INSTALLATION RESTORATION SITE 6

FIGURE A-1

SITE PLAN VIEW
NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CA

REVISION:
AUTHOR: A.CRABTREE
PROJECT NO:
FILE: SEE BELOW

TETRA TECH EC, INC.



BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CALIFORNIA

TASK-SPECIFIC PLAN FOR
INSTALLATION RESTORATION SITE 6

FIGURE A-2

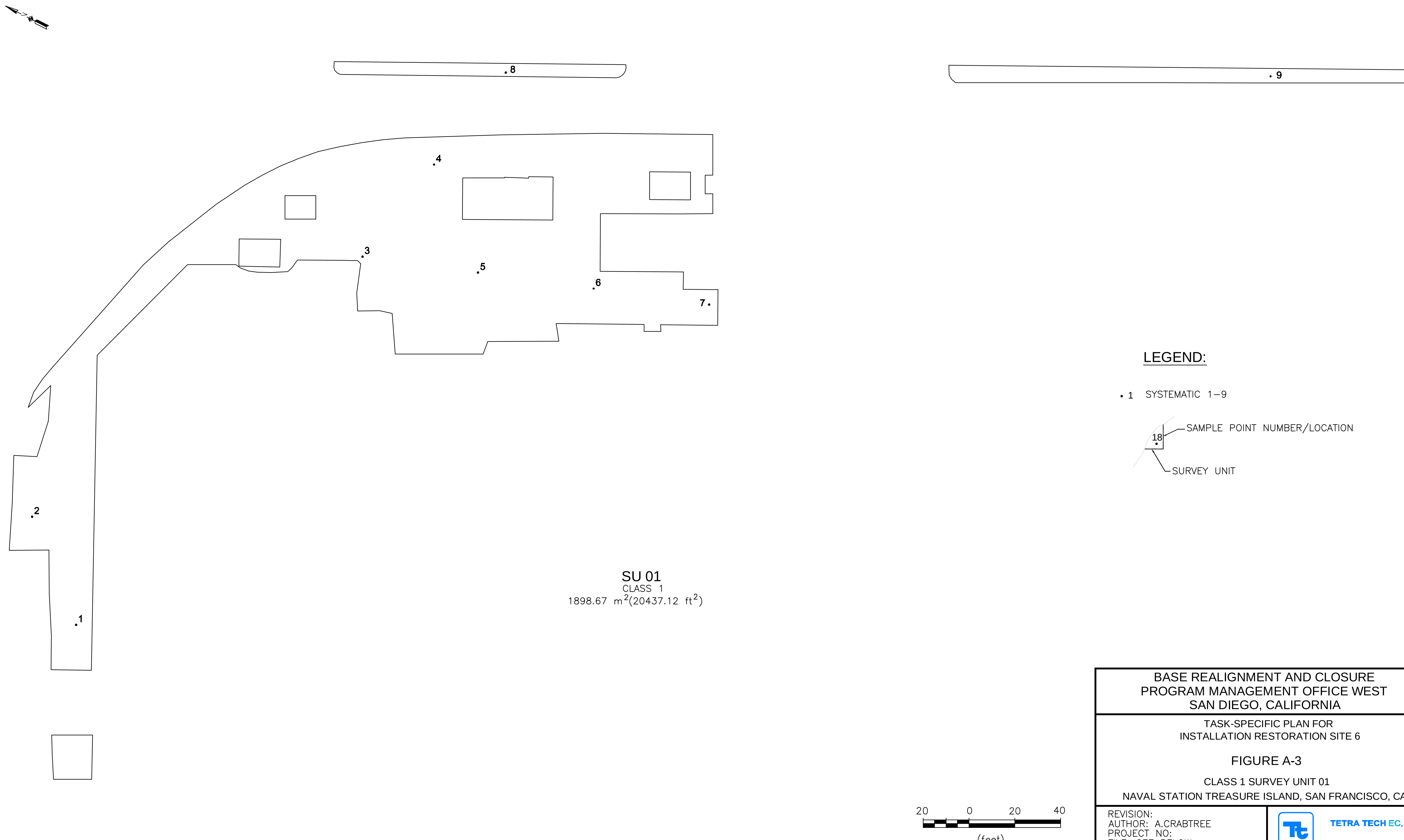
CLASS 1 SURVEY UNITS
NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CA

REVISION:
AUTHOR: A.CRABTREE
PROJECT NO:
FILE: SEE BELOW

TETRA TECH EC, INC.

P:\CAD Project Files\Treasure Island CAD Files\DWG\TI-Site 6_Figure A-2.dwg

9/19/14



BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CALIFORNIA

TASK-SPECIFIC PLAN FOR
INSTALLATION RESTORATION SITE 6

FIGURE A-3

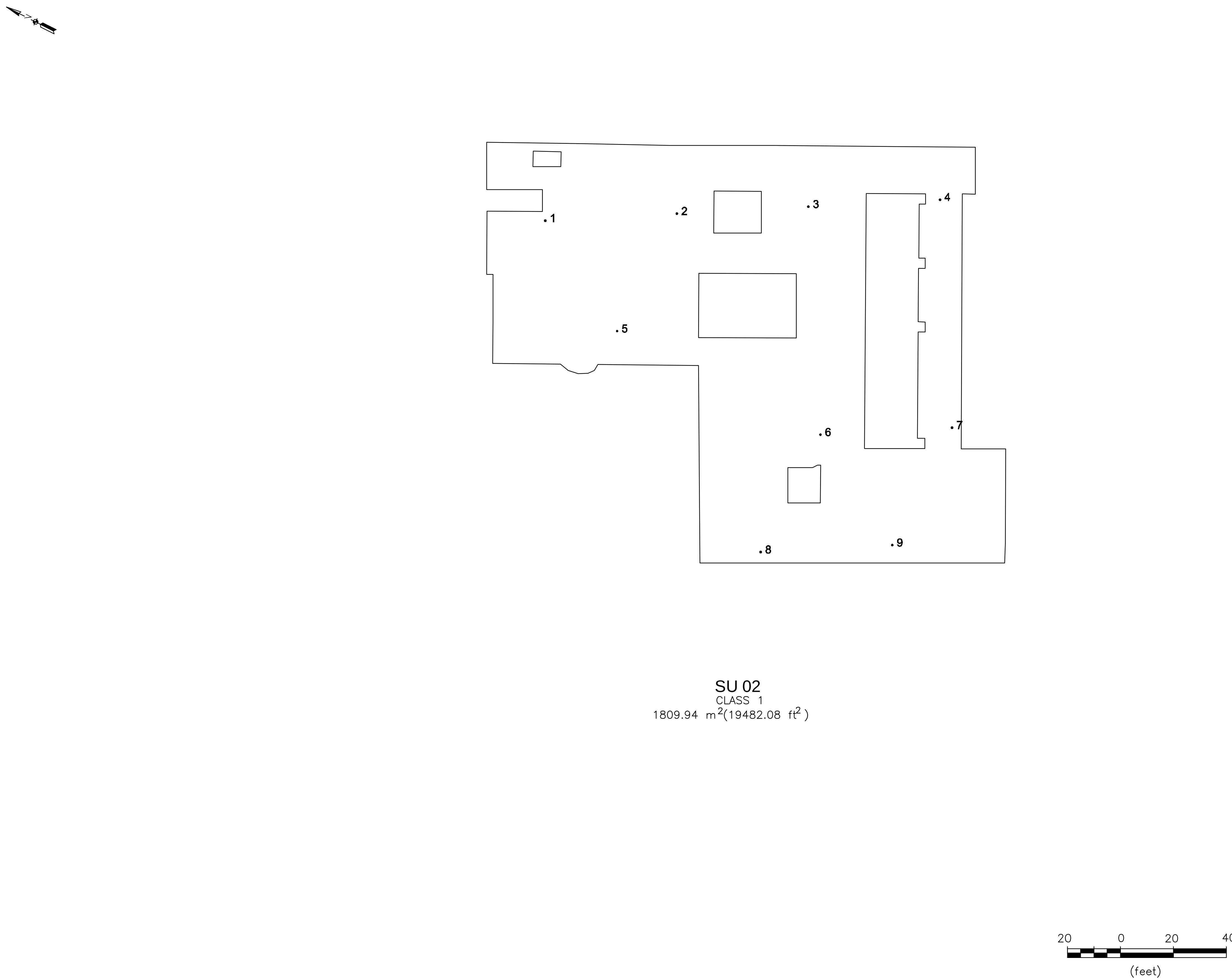
CLASS 1 SURVEY UNIT 01
NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CA

REVISION:
AUTHOR: A.CRABTREE
PROJECT NO:
FILE: SEE BELOW

TETRA TECH EC, INC.

P:\CAD Project Files\Treasure Island CAD Files\DWG\TI-Site 6_Figure A-14.dwg

9/8/14



LEGEND:

• 1 SYSTEMATIC 1–9

18 SAMPLE POINT NUMBER/LOCATION

SURVEY UNIT

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CALIFORNIA

TASK-SPECIFIC PLAN FOR
INSTALLATION RESTORATION SITE 6

FIGURE A-4

CLASS 1 SURVEY UNIT 02
NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CA

REVISION:
AUTHOR: A.CRABTREE
PROJECT NO:
FILE: SEE BELOW

TETRA TECH EC, INC.

P:\CAD Project Files\Treasure Island CAD Files\DWG\TI-Site 6_Figure A-14.dwg

9/8/14

SU 03
CLASS 1
1666.05 m^2 (18416.78 ft^2)

LEGEND:

• 1 SYSTEMATIC 1–9

18 SAMPLE POINT NUMBER/LOCATION

SURVEY UNIT

20 0 20 40
(feet)

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CALIFORNIA

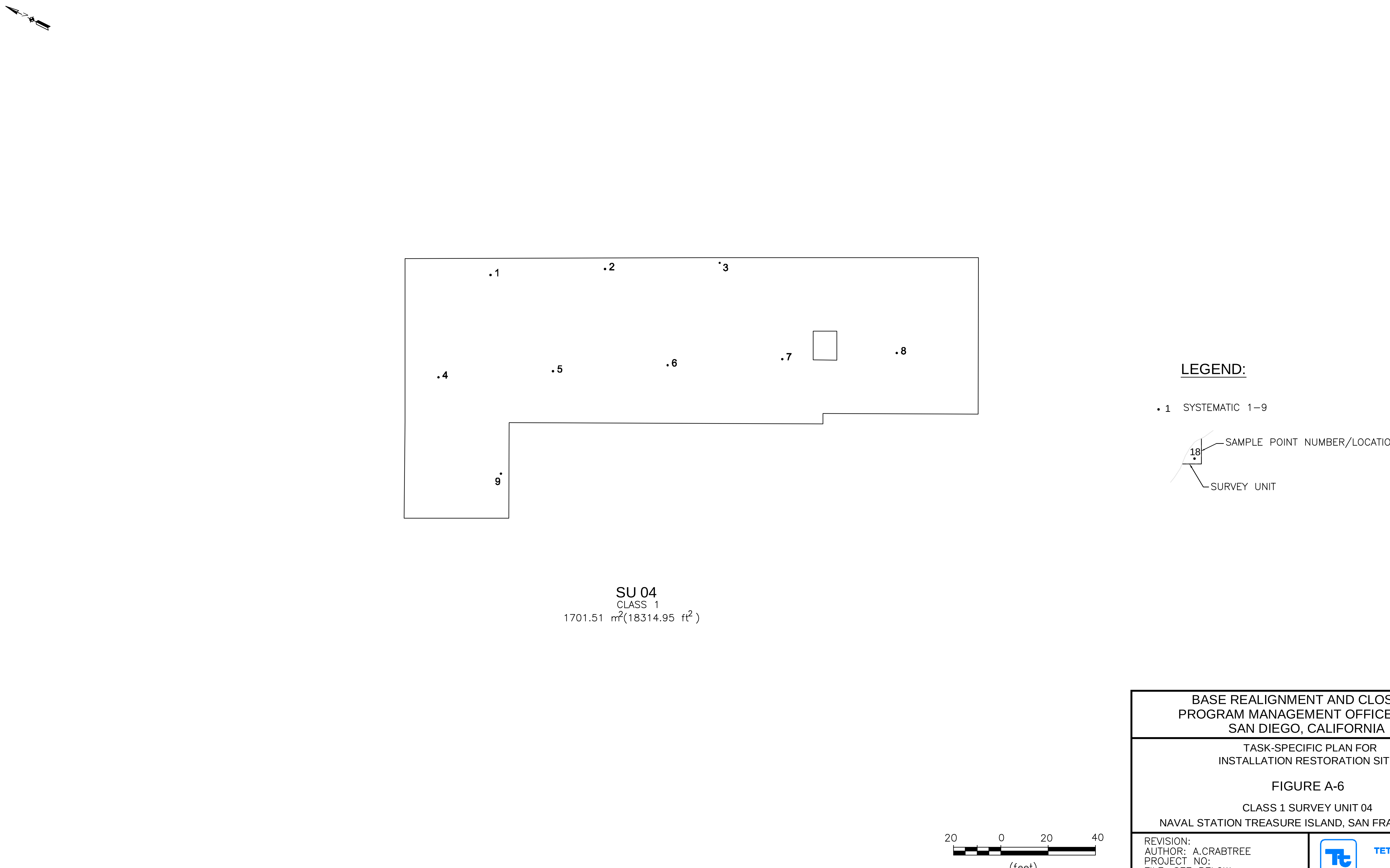
TASK-SPECIFIC PLAN FOR
INSTALLATION RESTORATION SITE 6

FIGURE A-5

CLASS 1 SURVEY UNIT 03
NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CA

REVISION:
AUTHOR: A.CRABTREE
PROJECT NO:
FILE: SEE BELOW

TETRA TECH EC, INC.



BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CALIFORNIA

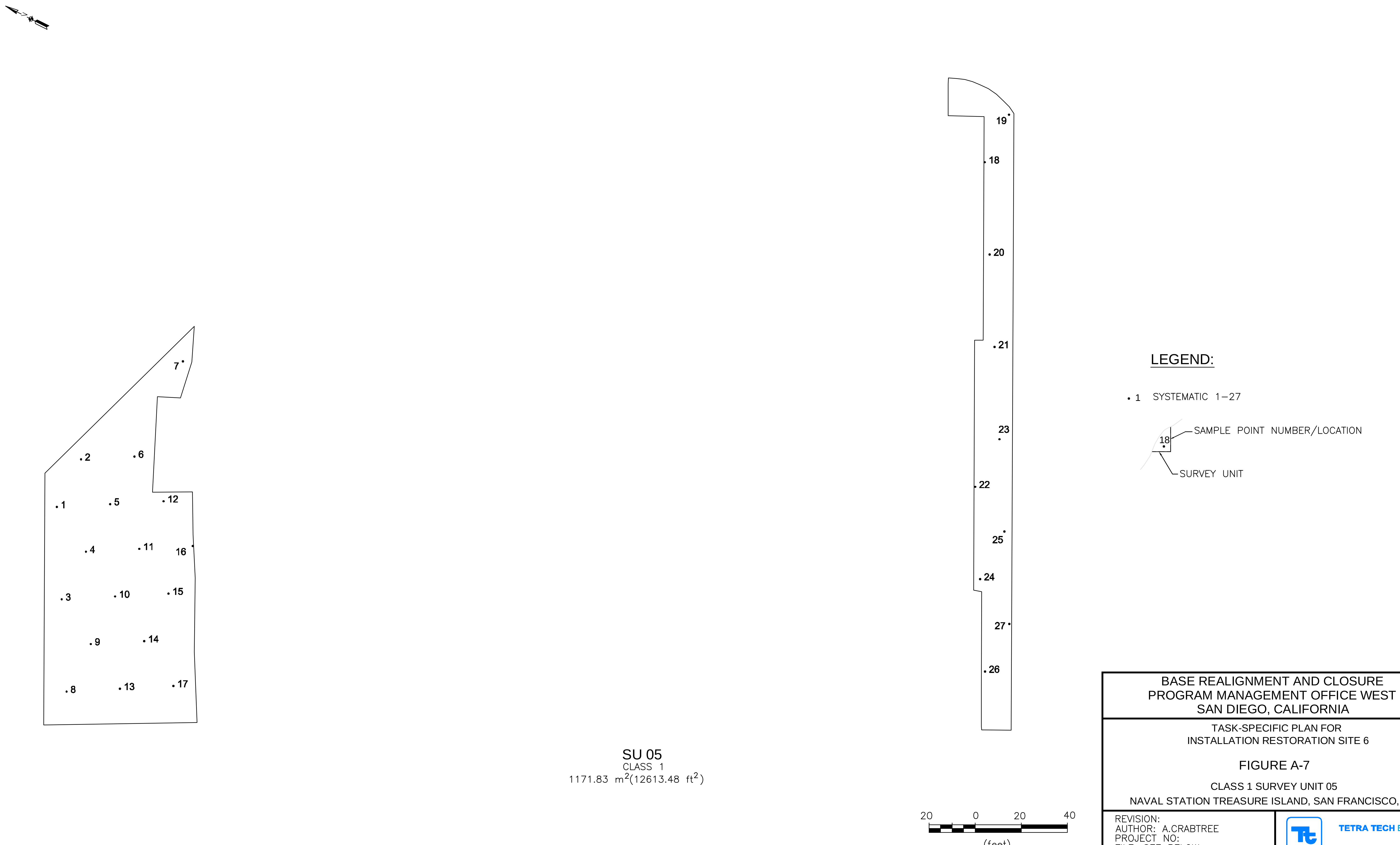
TASK-SPECIFIC PLAN FOR
INSTALLATION RESTORATION SITE 6

FIGURE A-6

CLASS 1 SURVEY UNIT 04
NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CA

REVISION:
AUTHOR: A.CRABTREE
PROJECT NO:
FILE: SEE BELOW

TETRA TECH EC, INC.



BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CALIFORNIA

TASK-SPECIFIC PLAN FOR
INSTALLATION RESTORATION SITE 6

FIGURE A-7

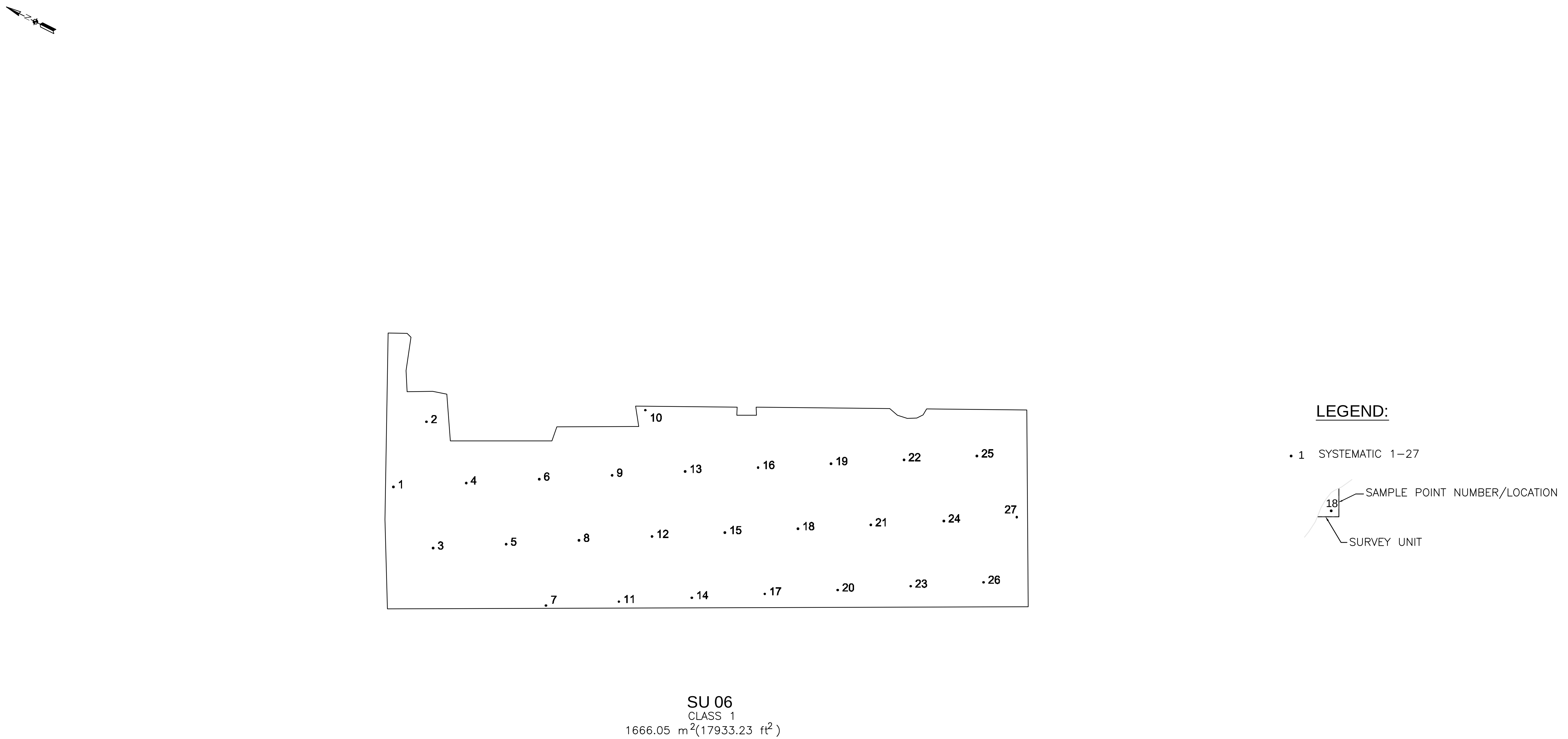
CLASS 1 SURVEY UNIT 05
NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CA

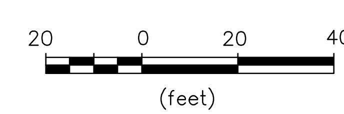
REVISION:
AUTHOR: A.CRABTREE
PROJECT NO:
FILE: SEE BELOW

TETRA TECH EC, INC.

P:\CAD Project Files\Treasure Island CAD Files\DWG\TI-Site 6_Figure A-3.dwg

9/2/14





BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CALIFORNIA

TASK-SPECIFIC PLAN FOR
INSTALLATION RESTORATION SITE 6

FIGURE A-8

CLASS 1 SURVEY UNIT 06
NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CA

REVISION:
AUTHOR: A.CRABTREE
PROJECT NO:
FILE: SEE BELOW

TETRA TECH EC, INC.

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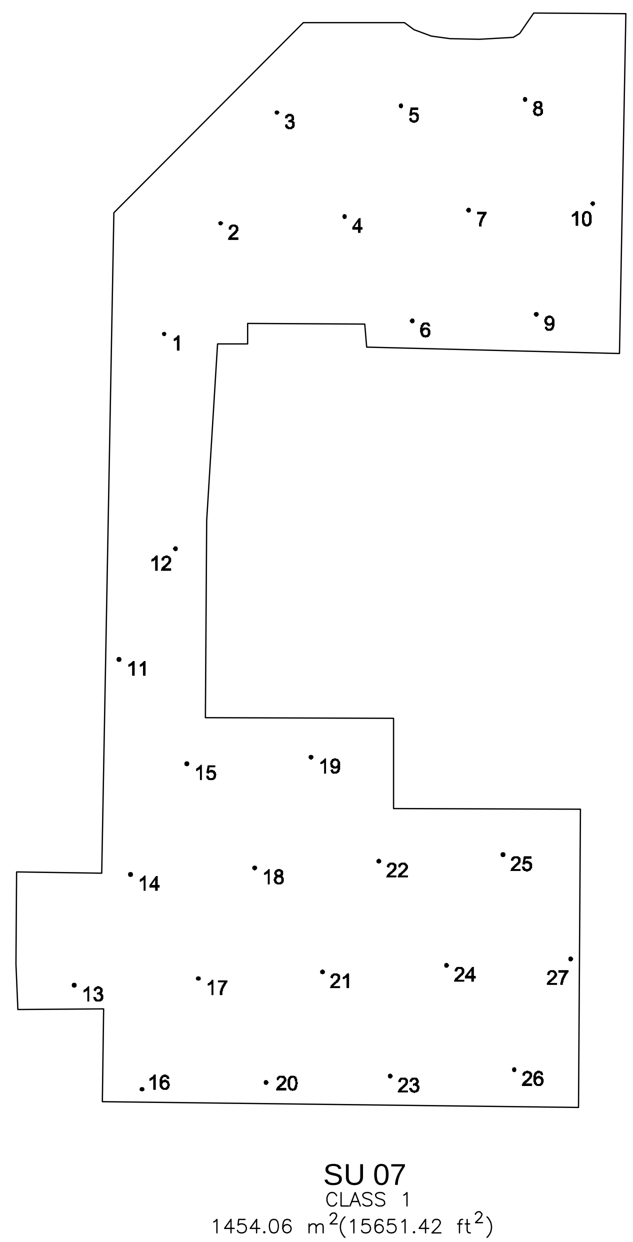

LEGEND:

• 1 SYSTEMATIC 1–27

18 SAMPLE POINT NUMBER/LOCATION

SURVEY UNIT

20 0 20 40

(feet)

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CALIFORNIA

TASK-SPECIFIC PLAN FOR
INSTALLATION RESTORATION SITE 6

FIGURE A-9

CLASS 1 SURVEY UNIT 07

NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CA

REVISION:
AUTHOR: A.CRABTREE
PROJECT NO:
FILE: SEE BELOW

TETRA TECH EC, INC.

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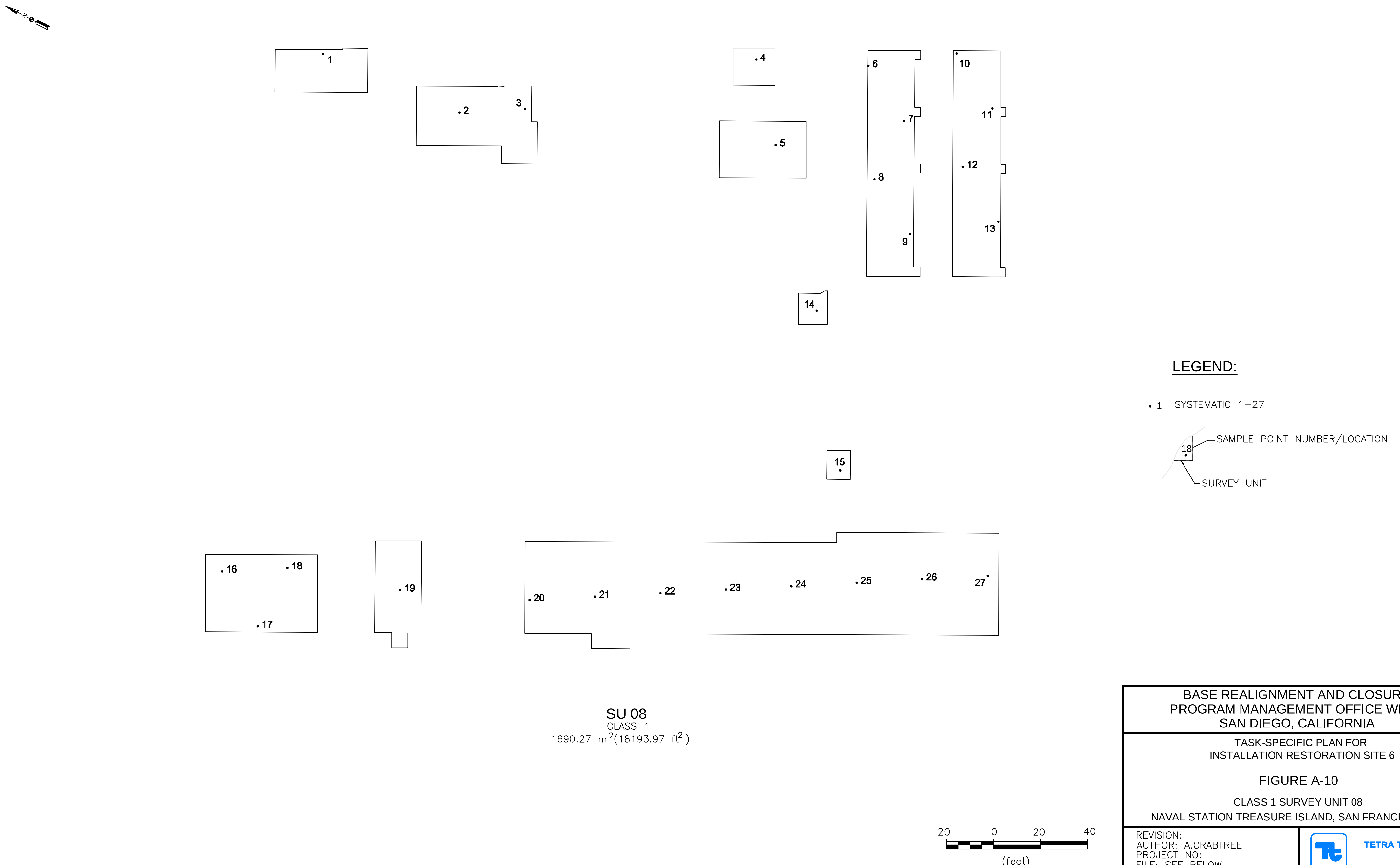

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CALIFORNIA

TASK-SPECIFIC PLAN FOR
INSTALLATION RESTORATION SITE 6

FIGURE A-10

CLASS 1 SURVEY UNIT 08
NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CA

REVISION:
AUTHOR: A.CRABTREE
PROJECT NO:
FILE: SEE BELOW

TETRA TECH EC, INC.

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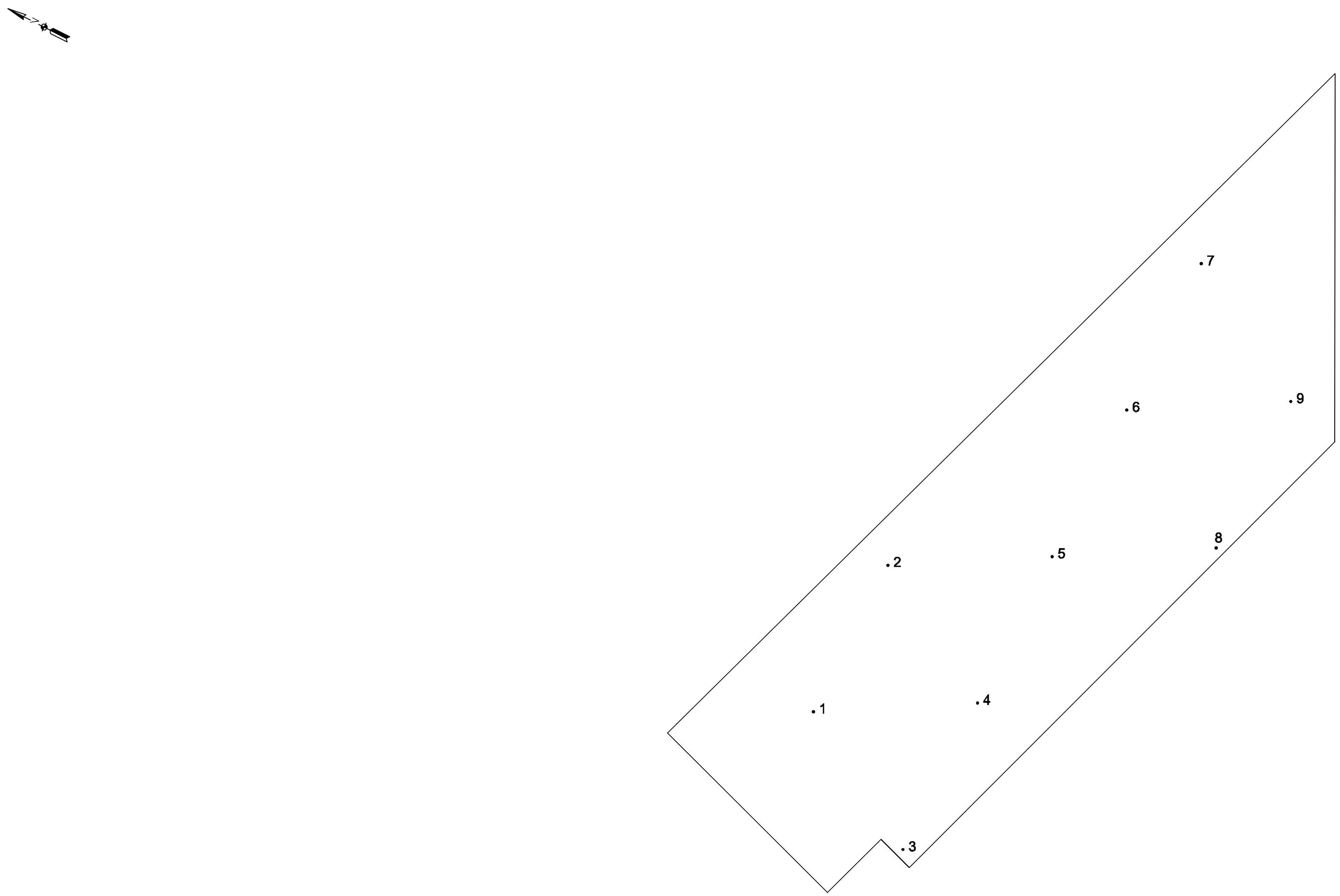

SU 09
CLASS 1
1800.56 m^2(19381.07 ft^2)

LEGEND:

• 1 SYSTEMATIC 1–9

18 — SAMPLE POINT NUMBER/LOCATION

— SURVEY UNIT

20 0 20 40
(feet)

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CALIFORNIA

TASK-SPECIFIC PLAN FOR
INSTALLATION RESTORATION SITE 6

FIGURE A-11

CLASS 1 SURVEY UNIT 09
NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CA

REVISION:
AUTHOR: A.CRABTREE
PROJECT NO:
FILE: SEE BELOW

TETRA TECH EC, INC.

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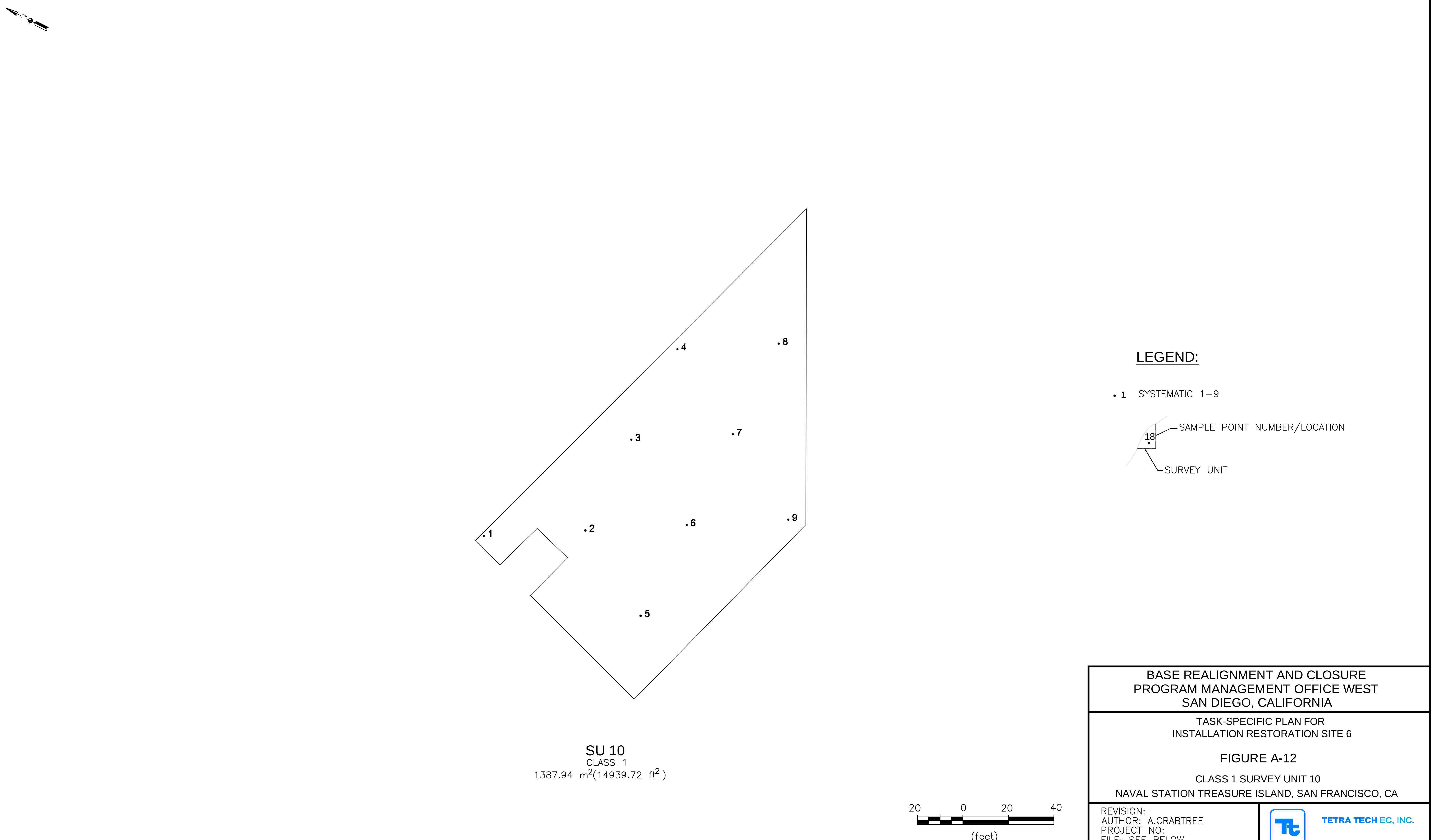
7/29/14



BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CALIFORNIA

TASK-SPECIFIC PLAN FOR
INSTALLATION RESTORATION SITE 6

FIGURE A-12

CLASS 1 SURVEY UNIT 10
NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CA

REVISION:
AUTHOR: A.CRABTREE
PROJECT NO:
FILE: SEE BELOW

TETRA TECH EC, INC.

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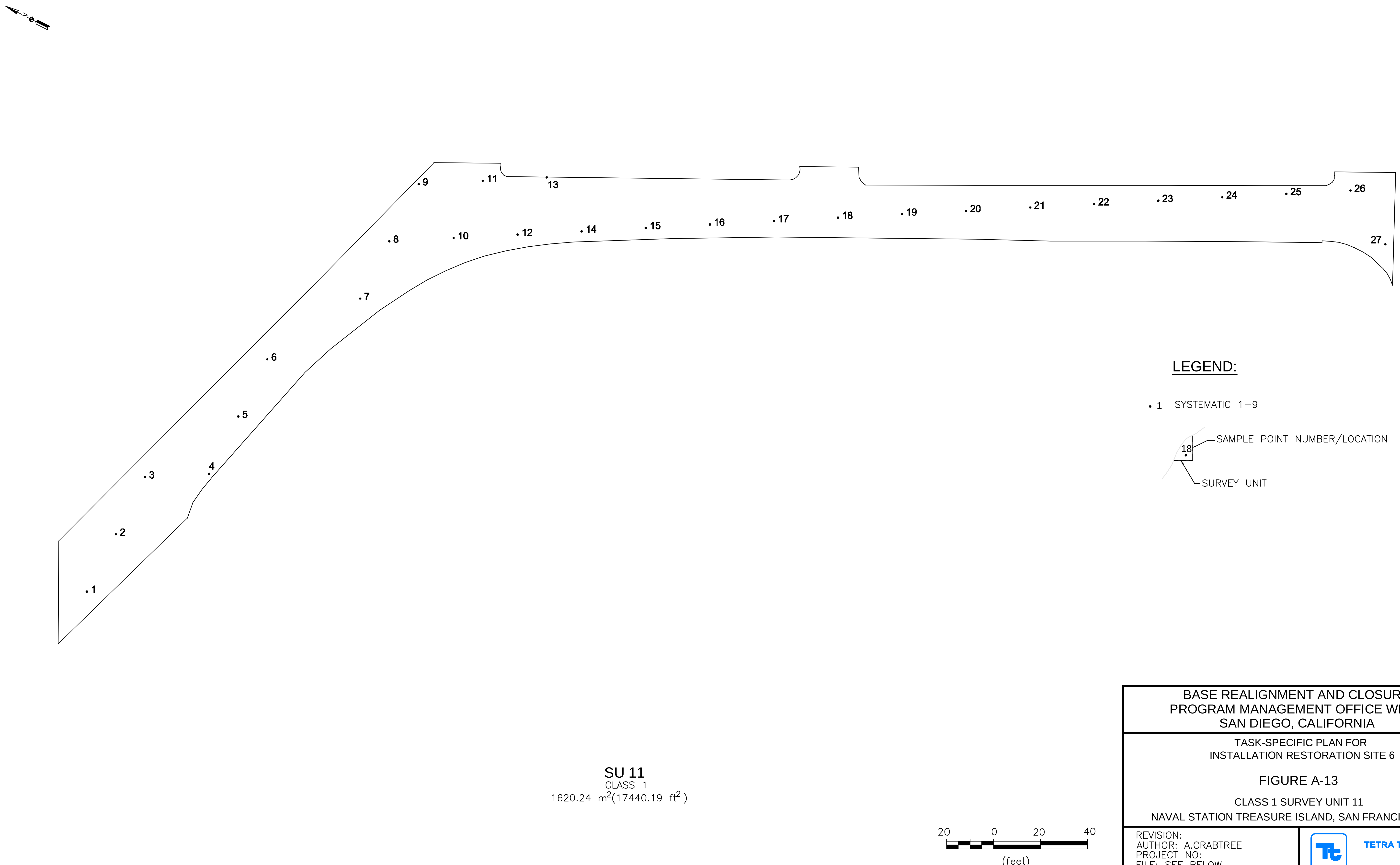

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CALIFORNIA

TASK-SPECIFIC PLAN FOR
INSTALLATION RESTORATION SITE 6

FIGURE A-13

CLASS 1 SURVEY UNIT 11
NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CA

REVISION:
AUTHOR: A.CRABTREE
PROJECT NO:
FILE: SEE BELOW

TETRA TECH EC, INC.

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9/8/14

APPENDIX B

APRIL 2009 GAMMA WALKOVER SURVEY DATA

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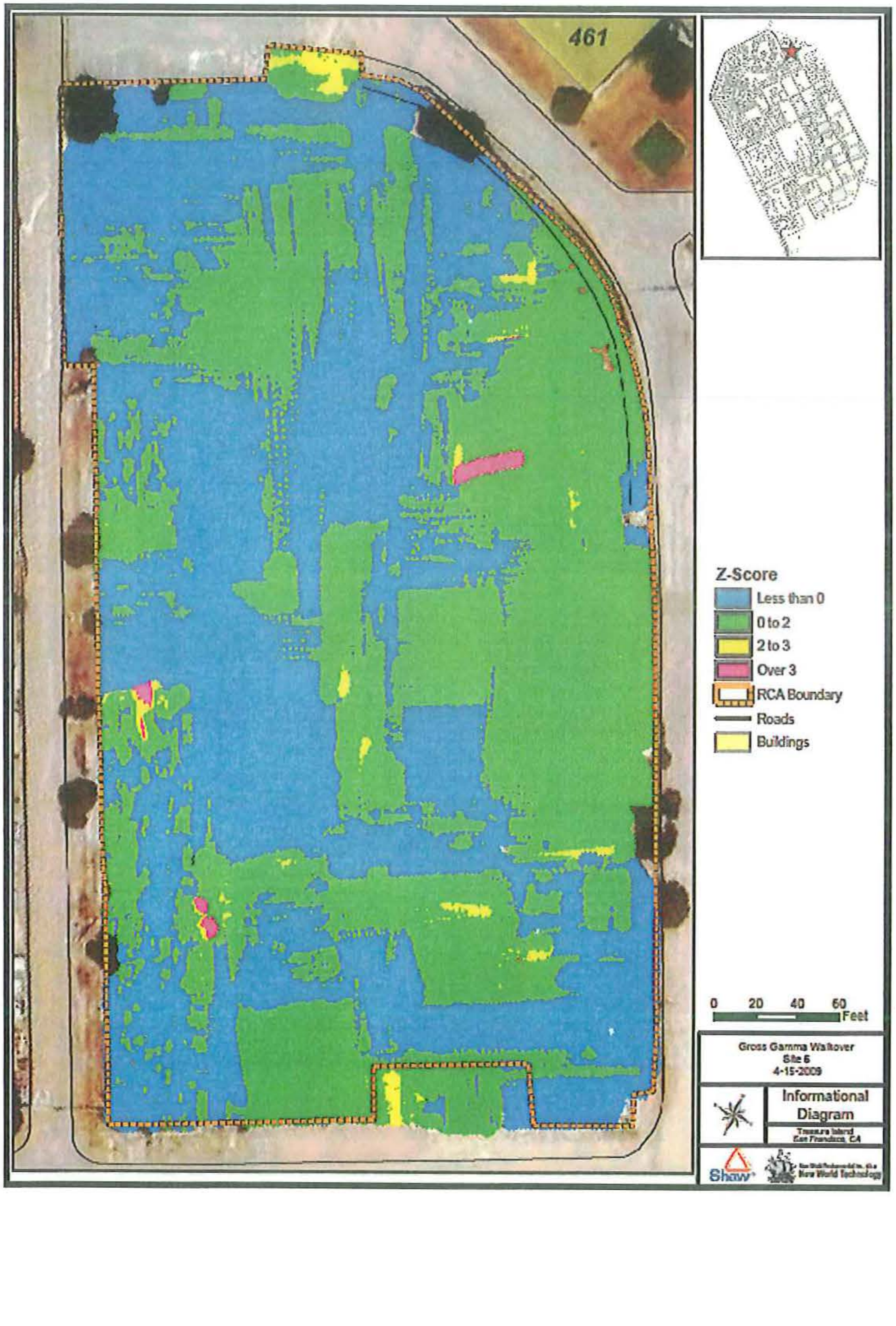
461
Z-Score
Less than 0
0 to 2
2 to 3
Over 3
RCA Boundary
Roads
Buildings
0
20
40
60
Feet
Gross Gamma Walkover
Site 6
4-15-2009
Informational
Diagram
Treasure Island
San Francisco, CA
Shaw
New World Technology

APPENDIX C

AVENUE M AND ACCESS ROAD SURVEY DATA

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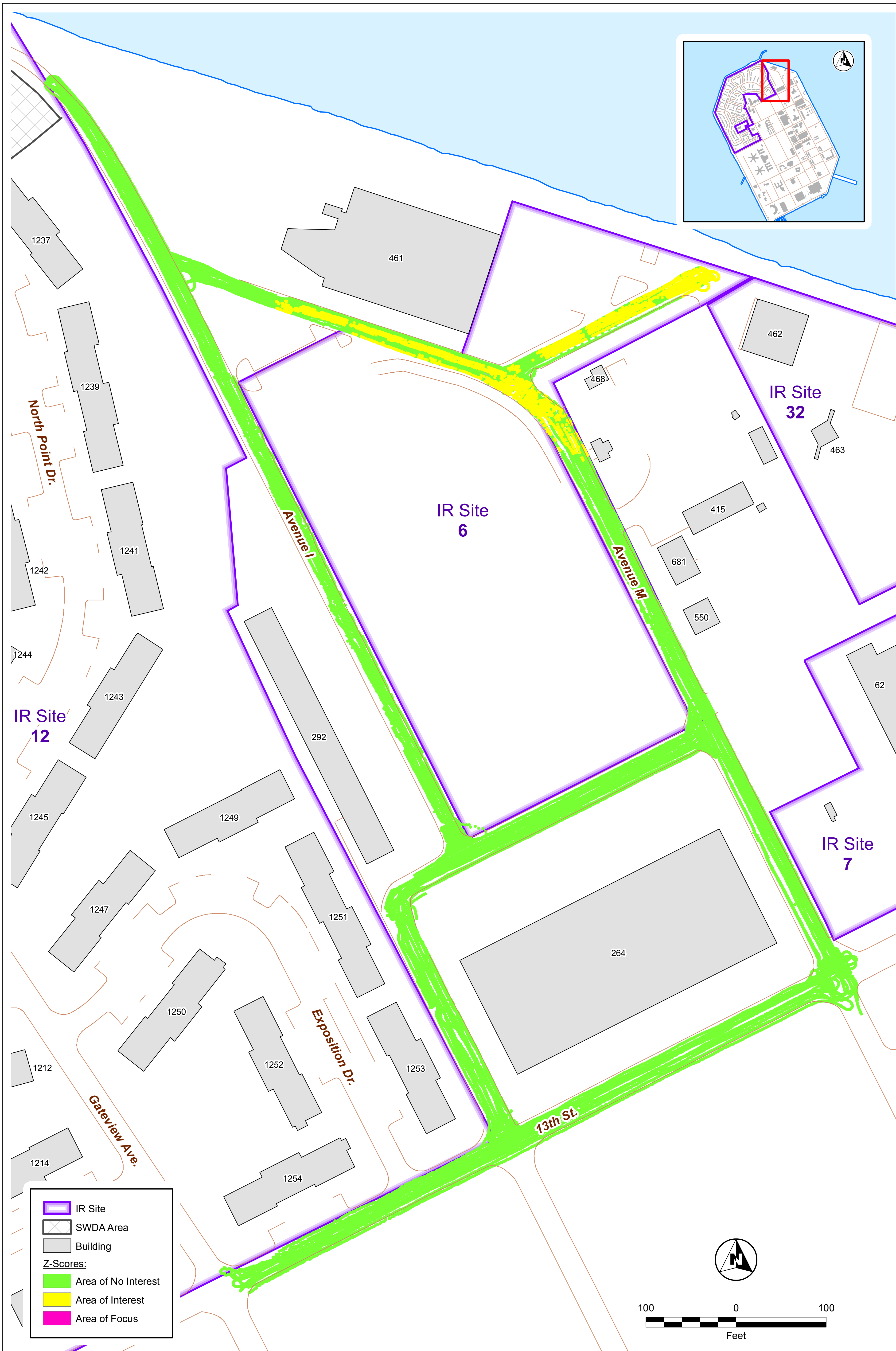

G:\ArcGIS\Navy\Treasure_Island\PROJECTS\TI_Rad_Web\Transportation_Routes\Z_Scores_Combined_06Mar2014.mxd 3/6/2014 AZHUK, Gilbane

Radiological Scoping Surveys
Department of the Navy
Naval Station Treasure Island
San Francisco, California

Figure 1
Z-Scores Overlay Map - Asphalt Transportation Routes